IDA

Joint
Advanced
Warfighting
Program

INSTITUTE FOR DEFENSE ANALYSES

Department of Defense Roadmap for Improving Capabilities for Joint Urban Operations

Volume I: Main Report

William J. Hurley, Task Leader

Alec Wahlman
COL Thomas Sward, USMC
Duane Schattle
Joel B. Resnick

March 2002

Distribution authorized to U.S. Government Agencies only per DoD Directive 5205.2; FOIA Exemption 2 applies.

IDA Paper P-3643

Log: H 01-001625

Requests for this document other than as specified on the cover must be referred to Deputy Under Secretary of Defense for Advanced Systems and Concepts, Office of the Under Secretary for Defense for Acquisition, Technology, and Logistics: November 26, 2002.

This work was conducted under contract DASW01 98 C 0067, Task AI-8-1627, for the Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics. The publication of this IDA document does not indicate endorsement by the Department of Defense, nor should the contents be construed as reflecting the official position of that Agency.

© 2001, 2003 Institute for Defense Analyses, 4850 Mark Center Drive, Alexandria, Virginia 22311-1882 • (703) 845-2000.

This material may be reproduced by or for the U.S. Government pursuant to the copyright license under the clause at DFARS 252.227-7013 (NOV 95).

INSTITUTE FOR DEFENSE ANALYSES
Joint Advanced Warfighting Program

IDA Paper P-3643

Department of Defense Roadmap for Improving Capabilities for Joint Urban Operations

Volume I: Main Report

William J. Hurley, Task Leader

Alec Wahlman
COL Thomas Sward, USMC
Duane Schattle
Joel B.Resnick

INSTITUTE FOR DEFENSE ANALYSES

Theodore S. Gold – Joint Advanced Warfighting Program

October 25, 2002

One of the operational goals for transformation identified in the Quadrennial Defense Review is to deny enemies sanctuary anytime anywhere. Perhaps the most challenging environment to accomplish this is the urban environment. The military options have been limited: we don't do cities, or we do them ugly—either rubbleization or every engagement a knife fight where lives are traded for information.

The military planner's desire to avoid military operations in cities is understandable—urban combat has been marked by great devastation and high casualties among both friendly forces and civilians. Nevertheless, it is prudent to plan for them. The political and economic importance of cities, the growth of urban areas, the lure of cities as refuges for friend and foe, and the possibilities for escalation from peacekeeping and other "operations other than war" are among the reasons we should pay considerable attention to improving our capabilities to operate militarily in these environments. The events of September 11th, the resulting prominence of the transnational threat, and possibility of military operations in Iraq further increase the military importance of urban environments.

The Department of Defense is striving for major enhancements of joint warfighting capabilities, and military operations involving urban environments are a part of that challenge. This two-volume report presents a roadmap to improve significantly the capabilities of future joint force commanders to conduct operations involving urban environments. The report identifies the capabilities needed to enable such improvement, and suggests the directions, projects, programs, and other initiatives to achieve these capabilities. Our intent is to increase attention to addressing the challenges of urban operations, and provide a framework for discourse and actions across all elements of DoD.

Recent efforts to improve urban capabilities have concentrated on the tactical level, enabling ground forces to better *cope* with the conditions of uncertainty, proximity, and vulnerability that characterize traditional tactical urban warfare. This report instead takes an operational-level approach to the challenges presented by the urban environment. This approach seeks ways to *understand* and *shape* the conditions of the tactical fight by exploiting joint capabilities for intelligence, surveillance, reconnaissance, information operations, and remote strike to reduce the number of close-up

tactical engagements necessary, and to provide advantages to our tactical forces in position, tempo, information, fires, and support.

Realizing the promise of these new approaches will require initiatives across all elements of doctrine, organization, training, materiel, leadership, and new technologies (e.g., advances in sensors, communication networks, unmanned vehicles, and non-lethal effects). The Roadmap identifies promising paths to pursue—but if DoD is to succeed, it must think, organize, and invest differently regarding its preparations for urban operations.

In developing the Roadmap, the JAWP team drew upon the expertise of dozens of individuals from throughout DoD and non-DoD organizations. The results reflect both their concern that improving urban capabilities is an important national challenge and their ideas as to how to go about it. This network of expertise will be an important asset as the Department pursues better ways to conduct military operations in urban environments

This JAWP paper is one in a series of IDA publications that addresses the importance of cities in modern warfare. Others include:

War and Urban Terrain in the Twenty-First Century (addresses the continued importance of cities in modern warfare)
Military Operations in Urban Terrain: A Survey of Journal Articles (summarizes recent thinking on the subject)
Workshop on Advanced Technologies for Urban Operations, November 14-15, 2000: Summary of Proceedings (identifies technologies that could lead to significant improvements in urban capabilities)
Taking the "Revolution in Military Affairs" Downtown: New Approaches to Urban Operations (summarizes some of the main ideas contained in the Roadmap)

I invite your comments and feedback, which should be directed to:

Joint Advanced Warfighting Program
ATTN: William J. Hurley
4850 Mark Center Drive
Alexandria, VA 22311-1882
Telephone: (703) 845-2415
Fax: (703) 845-6810
E-mail: whurley@ida.org

Ted Gold

Recent Publications of The Joint Advanced Warfighting Program

Experimentation

Experimental Units: The Historical Record, Williamson Murray, IDA Paper P-3684, May 2002.

Lessons Learned: Commanding a Digital Brigade Combat Team, Rick Lynch, IDA Paper P-3616, June 2001.

US Army and US Marine Corps Interoperability: A Bottom-up Series of Experiments, Rick Lynch, Tom O'Leary, Tom Clemons, and Doug Henderson, IDA Paper P-3537, November 2000.

Experimentation in the Period Between the Two World Wars: Lessons for the Twenty-First Century, Williamson Murray, IDA Document D-2502, forthcoming.

Lessons Learned from the First Joint Experiment (J9901), Larry D. Budge and John Fricas, IDA Document D-2496, October 2000.

The Joint Experiment J9901: Attack Operations Against Critical Mobile Targets, Joint Advanced Warfighting Program, September 29, 2000. Prepared for the US Joint Forces Command.

Joint Warfighting Experimentation: Ingredients for Success, James H. Kurtz, IDA Document D-2437, September 2000.

Framework for Joint Experimentation—Transformation's Enabler, Karl Lowe, IDA Document D-2280, January 1999.

Joint Concept Development

Applying Rapid Decisive Operations: Possibilities for 2010, Karl H. Lowe, IDA Paper P-3602, December 2001.

Department of Defense Roadmap for Improving Capabilities for Joint Urban Operations, two volumes, William J. Hurley, Alec C. Wahlman; COL Thomas Sward, USMC; Duane Schattle; and Joel B. Resnick, IDA Paper P-3643. For Official Use Only.

Future Joint Force Headquarters, Scott Schisser, IDA Paper P-3601, December 2001.

An Historical Perspective on Effects-Based Operations, Williamson Murray, with Thomas O'Leary, Joel Resnick, Dennis Gleeson, and Gwen Linde, IDA Paper P-3606, October 2001.

Taking the Revolution in Military Affairs Downtown: New Approaches to Urban Operations, William J. Hurley, IDA Paper P-3593, August 2001. For Official Use Only.

Joint Strike Force Operational Concept, Rick Lynch, David Bolanos, Thomas Clemons, Kathleen Echiverri, Dennis J. Gleeson, Jr., Doug Henderson, Aleksandra Rohde, Scott Schisser, IDA Paper P-3578, July 2001. For Official Use Only.

New Perspectives on Effects-Based Operations: Annotated Briefing, Dennis J. Gleeson, Gwen Linde, Kathleen McGrath, Adrienne Murphy, Williamson Murray, Tom O'Leary, Joel B. Resnick, IDA Document D-2583, June 2001.

War and Urban Terrain in the Twenty-First Century, Williamson Murray, IDA Paper P-3568, November 2000.

Military Operations in Urban Terrain: A Survey of Journal Articles, D. Robert Worley, Alec Wahlman, and Dennis Gleeson, Jr., IDA Document D-2521, October 2000.

Transformation Process

Military Transformation and Legacy Forces, Williamson Murray and Thomas O'Leary, IDA Paper P-3633, April 2002.

Red Teaming: Shaping the Transformation Process. Annotated Briefing, John Sandoz, IDA Document D-2590, June 2001.

Thinking About Innovation, Williamson Murray, IDA Paper P-3576, June 2001.

Red Teaming: A Means for Transformation, John F. Sandoz, IDA Paper P-3580, January 2001.

Developing Metrics for DoD's Transformation, Joel B. Resnick, IDA Document D-2528, October 2000.

Seminars and Workshops

Workshop on Advanced Technologies for Urban Operations, November 14-15, 2000: Summary of Proceedings, William J. Hurley, IDA Document D-2574, June 2001. For Official Use Only.

Joint Advanced Warfare Seminar, James H. Kurtz, Daniel E. Moore, and Joel B. Resnick, IDA Document D-2346, July 1999.

Workshop on Advanced Technologies and Future Joint Warfighting, April 8–10, 1999: Summary of Proceedings, William J. Hurley, Phillip Gould, and Nancy P. Licato, IDA Document D-2343, May 1999.

General

FY2001–2002 End of Year Report, Theodore S. Gold et al., multi-volume set, forthcoming.

FY2000 End of Year Report: Volumes I, II, and III, Theodore S. Gold et al., IDA Paper P-3571, November 2000.

Preface

This paper was prepared under the task order Joint Advanced Warfighting Program (JAWP) for the Deputy Assistant Secretary of Defense for Resources and Plans in the Office of the Under Secretary of Defense for Policy. The paper addresses the task order objective of generating advanced joint operational concepts and joint experimentation to assist the Department of Defense in transforming US military capabilities.

The JAWP was established at the Institute for Defense Analyses (IDA) by the Office of the Secretary of Defense and the Joint Staff to serve as a catalyst for stimulating innovation and breakthrough change. The JAWP Team is composed of military personnel on joint assignments from each Service and civilian analysts from IDA. The JAWP is located principally in Alexandria, Virginia, and includes an office in Norfolk, Virginia, that facilitates coordination with the United States Joint Forces Command.

This paper does not necessarily reflect the views of IDA or the sponsors of the JAWP. Our intent is to stimulate ideas, discussion, and, ultimately, the discovery and innovation that must fuel successful transformation.

Acknowledgements

Throughout the development of the Roadmap, the Roadmap Team solicited input from dozens of contributors from within and outside the Department of Defense, many of whom have drafted portions of the text. Indeed, the Roadmap is an attempt to bring the thinking of these individuals together into a common framework. These interactions ranged from one-on-one encounters to more formal workshops and conferences.

Of course, given the complexity of the subject, there are differing views on how best to proceed. However, there was essential unanimity within this group concerning the importance of energetically addressing this challenge to the nation, and all freely contributed their time and ideas. The Roadmap Team of the Joint Advanced Warfighting Program is indebted to these individuals. We have come to view the Roadmap not only as a document that suggests the way ahead but also as a focal point for a network of individuals representing many areas of expertise who are dedicated to improving urban capabilities. (Note that their contributions do not necessarily represent the official positions of their organizations. The Roadmap is intended to be *input* to an official decision-making process, not the result of one.)

We would like to acknowledge the sponsors who initiated this work and provided consistent support:

Dr. James N. Miller, Dr. Chris Lamb and COL Mark Mahaffey, USMC, Office of the Under Secretary of Defense for Policy (Strategy and Threat Reduction)

Mr. Joseph Eash, Mr. Robert Shields, and Mr. Charles Kimzey, Advanced Systems and Concepts, Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics

The Roadmap Team is pleased to acknowledge the following contributors:

During the course of its development, members of the Roadmap Team benefited from participation in the meetings of several working groups addressing various aspects of urban operations. These included:

The Joint Urban Operations Working Group (chaired by LtCol Joseph Perry, USMC)

The Defense Intelligence Urban Working Group (chaired by Mr. Kenneth Parr and Mr. David Dilegge)

The Office of the Secretary of Defense Urban Working Group (chaired by Mr. Duane Schattle)

The NATO Study Group on Urban Operations in 2020 (chaired by LtCol Silas Suchanek, UK Army, and Col Philip Baxter, UK Army)

Special acknowledgements for contributions to the Roadmap text are given to:

CAPT Paul Barry, USN, Joint Advanced Warfighting Program, Institute for Defense Analyses

Mr. John Bastone, US Army Dismounted Battlespace Battle Lab

Mr. Willard M. (Chris) Christenson, Strategy, Forces and Resources Division, Institute for Defense Analyses

Mr. David Dileggi, US Marine Corps Intelligence Agency

Mr. Fred Dupont, US Army Dismounted Battlespace Battle Lab

Mr. Joseph Ellis, SAIC, USAF Air Staff

Ms. Carol J. Fitzgerald, US Army Soldier and Biological Chemical Command; Technology Program Manager, Military Operations in Urban Terrain Advanced Concept Technology Demonstration

Mr. Dennis Gleeson, Joint Advanced Warfighting Program, Institute for Defense Analyses

Dr. Russell W. Glenn, Rand Corporation

Ms. Kathleen Griggs, consultant, Defense Advanced Research Projects Agency

Mr. Michael D. Halloran, USMC, Clear Facilities Office

Mr. David Hanson, USMC, Clear Facilities Office

Mr. Joseph Heineman, Office of the Under Secretary of Defense for Readiness and Training

MAJ Douglas McCullum, USA, Army Staff, G3

CAPT Dan Moore, USN, Joint Advanced Warfighting Program, Institute for Defense Analyses

Dr. Williamson Murray, Joint Advanced Warfighting Program, Institute for Defense Analyses

Mr. Robert O'Connell, National Ground Intelligence Center

Mr. Humberto Rodriguez, Joint Directorate for Non-Lethal Weapons

MAJ J. Scot Sauer, USMC, US Marine Corps Warfighting Laboratory

Col Robert Stephan, USAF, National Defense University

Mr. Peter Wallace, US Army Soldier and Biological Chemical Command

Mr. Jimmy Walters, Booze, Allen, Hamilton Corp.

Dr. D. Robert Worley, Computer and Software Engineering Division, Institute for Defense Analyses

And special thanks for comments and suggestions during the development of the Roadmap are given to:

Mr. John Allison, US Marine Corps Warfighting Laboratory

Mr. Gary Anderson, Center for Emerging Threats and Opportunities

COL Joseph Anderson, USA/Naval War College

Mr. Larry Brady, Joint Forces Staff College

Mr. Chris Chartier, OSD, Decision Support Center

Mr. Carl Ernst, Booze, Allen, Hamilton Corp.

COL George Fenton, USMC, Joint Directorate for Non-Lethal Weapons

Mr. John Foley, Joint Directorate for Non-Lethal Weapons

Mr. Randy Gangle, US Marine Corps Warfighting Laboratory

Mr. Ernie Gurany, National Ground Intelligence Center

LTC Paul Harwig, USA, National Imagery and Mapping Agency

Col. Charles Higbee, Office of the Secretary of Defense (Special Operations and Low Intensity Conflict)

Mr. A. J. Kessel, Joint Directorate for Non-Lethal Weapons

Mr. Chris Nerney, Joint Warfare Analysis Center

Mr. John Lellenberg, Office of the Secretary of Defense (Special Operations and Low Intensity Conflict)

LtCol Robert McCaleb, USMC, Office of the Secretary of Defense (Program Analysis and Evaluation)

Ambassador Robert Oakley, National Defense University

Mr. Thomas O'Leary, Joint Advanced Warfighting Program, Institute for Defense Analyses

Maj Kevin H. Psmithe, USAF, Air Staff

COL Aleksandra Rohde, Army National Guard

Mr. John Stillion, Rand Corporation

Mr. Timothy L. Thomas, Foreign Military Studies Office

Mr. Bert Tussing, US Army War College

Mr. Alan Vick, Rand Corporation

Mr. John Walsh, Office of the Undersecretary of Defense for Readiness and Training

Mr. Marty Westfall, Joint Warfare Analysis Center

Mr. Stephen White, National Ground Intelligence Center

Contents

Volume I: Main Report

Executive Summary S–1

I. Introduction I–1
- A. The Nature of Urban Warfare I–1
- B. Current US Approach to Urban Operations I–2
- C. Concerns with the Current Approach I–3
- D. The Importance of the Urban Environment in Twenty-First Century Conflict I–3
- E. Significant Improvements in Urban Capabilities Are Possible I–5
- F. Plan of This Document I-6

II. New Approach to Urban Operations II–1
- A. Background II–1
- B. A Conceptual Framework II–3
- C. Understand II–3
- D. Shape II–5
- E. Engage II–6
- F. Consolidate II–7
- G. Transition II–8
- H. Summary II–8

III. Determining Needed Capabilities and Assessing Status III–1
- A. Definition and Focus III–1
- B. An Illustration of the Roadmap Process III–2

IV. Recent and Current Programs and Activities IV–1
- A. Landscape of Programs and Activities IV–1
- B. Sub-Roadmaps IV–2
- C. Sub-Roadmaps: USECT IV–3
- D. Sub-Roadmaps – Supporting Activities IV–11
- E. Summary of Overall Patterns in Ongoing MOUT Efforts IV–12
- F. Sub-Roadmaps – DoD Organizations IV–13
  1. Office of the Secretary of Defense IV–14
  2. Joint Staff IV–15
  3. US Army IV–17
  4. US Navy IV–20
  5. US Air Force IV–21
  6. US Marine Corps IV–24

G. Intelligence Support to Urban Operations IV–26
H. Joint Non-Lethal Weapons Program IV–32

V. Directions for Improving Urban Capabilities: Operational Capabilities V–1
A. Understand V–1
B. Shape V–6
C. Engage V–13
D. Consolidate V–15
E. Transition V–16

VI. Directions for Improving Urban Capabilities: Supporting Activities VI–1
A. Doctrine VI–1
B. Organization VI–3
C. Training VI–5
D. Materiel VI–8
E. Leadership VI–9
F. People VI–10
G. Facilities VI–11
H. Policy and Legality VI–13
I. Coalition, Interagency, and NGOs VI–16
J. Concept Development and Experimentation VI–19
K. Modeling and Simulation VI–22

VII. Implementing the Roadmap VII–1
A. Introduction VII–1
B. Alternative Approaches to Implementation VII–1
C. Steps to Improve Implementation Prospects VII–2
D. Conclusions VII–8

Appendices

Appendix A. MOUT Programs and Activities by Principal Sponsor A–1

This appendix presents brief descriptions of the timeline entries displayed in Chapter IV of Volume I. Unlike Chapter IV, which broke out the efforts primarily by the USECT scheme, this list categorizes activities by their primary sponsor. Within each sponsor's section the entries are alphabetized. The first index, Programs by Organization, lists the programs by organization, then alphabetically by title. The second index, Programs by Title, lists the programs alphabetically by name.

Appendix B. Current Activities and Future Directions for Ground Vehicles, Medical Support, and Mobile Robots B–1

I. Ground Vehicles In Urban Operations B–3
A. Armor Protection B–3
B. Communications B–4
C. Vehicle Design B–4

D. Training B–4
E. Mobility B–4
F. Firepower B–5
G. Logistics B–5
H. Current Activities B–5
I. Some Possible Directions B–8
J. Conclusions B–9

II. Medical Support in Urban Operations B–9
A. Understand B–9
B. Shape B–10
C. Engage B–10
D. Consolidate, Transition B–11
E. Conclusions B–11

III. Mobile Robots for Urban Operations B–12
A. Mobility B–12
B. Delivery Systems B–13
C. Form B–13
D. C3I B–13
E. Video Information B–14
F. Video Guidance and Control B–14
G. Video Networks B–14
H. NETEX (NETworks in the Extreme) B–15
I. Conclusions B–15

Appendix C. Bibliography C–1

This appendix contains the bibliography, first grouped by subject and then by author. Subject areas include (1) aviation; (2) combined arms, armor; (3) C4ISR, leadership; (4) doctrine; (5) experimentation; (6) general; (7) history; (8) logistics; (9) training.

Appendix D. Glossary D–1

Illustrations

Figure S–1. Types of Urban Missions S–7
Figure S–2. Types of Operational Concepts (CAPTURE AN URBAN AREA) S–8
Figure S–3. Mission – Operational Concept – Capability Relationship S–10
Figure III–1. Conditions Affecting Urban Operations (Mogadishu Examples) III–3
Figure III–2. Some Types of Operational Concepts: CAPTURE AN URBAN AREA III–5
Figure IV–1. MOUT Activities: Understand IV–4
Figure IV–2. MOUT Activities: Shape IV–6
Figure IV–3. MOUT Activities: Engage IV–8
Figure IV–4. MOUT Activities: Consolidate IV–9
Figure IV–5. MOUT Activities: Transition IV–10
Figure IV–6. MOUT Supporting Activities (1) IV–11
Figure IV–7. MOUT Supporting Activities (2) IV–11

Table S–1. Roadmap Process S–6
Table S–2. Types of Urban Missions S–6
Table S-3. Urban Capabilities Within USECT Categories S–9
Table S–4. Landscape of Initiatives for Improving Urban Capabilities S–11
Table S–5. Program Summary (Costs in $M/year) S–25
Table III–1. Types of Urban Missions III–3
Table IV–1. Landscape of Initiatives for Improving Urban Capabilities IV–2
Table IV–2. Concept Exploration Program Efforts IV–38

Volume II: MOUT
Operational Concepts and Capabilities: The Joint Force Commander's Perspective

I. Introduction I–1

II. Operational Concepts II–1

III. Needed Capabilities III–1

IV. Urban Combat Variables IV–1

V. Patterns in Operational Concepts and Capabilities V–1

VI. Conclusions VI–1

Appendix A. Operational Concepts and Needed Capabilities A–1

Appendix B. Summary of Needed Capabilities and Current Grades B–1

Appendix C. Summary of Urban Variable Impacts C–1

Appendix D. Remaining Missions and Related Operational Concepts D–1

Appendix E. Relationship Between the Urban Roadmap and the Joint Warfighting Science and Technology Plan E–1

Appendix F. Bibliography F–1

Appendix G. Glossary G–1

Illustrations

Figure I–1. Mission – Operational Concept – Capability Relationship I–3

Figure II–1. Types of Operational Concepts (CAPTURE AN URBAN AREA) II–1

Figure V–1. Capability Demands for Traditional and New Operational Concepts V–7

Figure A–1. Types of Operational Concepts (Capture an Urban Area) A–2

Figure D–1. Types of Operational Concepts (CAPTURE AN URBAN AREA) D–3

Figure D–2. Summary of Operational Concepts Not Addressed Under Capture an Urban Area D–9

Table D–1. Types of Urban Missions D–3

Summary

I. Introduction

Over the coming decades the US military will almost certainly be called upon to conduct operations in areas characterized by man-made structures, noncombatants and infrastructures, i.e., urban areas. Urban areas are political, cultural, and financial centers; and they act as hubs for transportation, information, and manufacturing. Most scenarios at the lower levels of conflict, including counter-terrorism, focus on civilians, and therefore on urban areas.

The urban environment constrains many of the advantages that US forces currently enjoy in open environments. Operations in urban environments involve risks of high casualties to friendly forces and noncombatants, as well as extensive collateral damage. In many scenarios, such unintended consequences may, in themselves, defeat the goals of US involvement.

The challenge for the Department of Defense (DoD) is twofold:

- to improve the urban capabilities of current legacy forces, which have been primarily designed for operations in open environments; and
- to develop new approaches that address the unique demands of urban operations and that hold the promise of dramatic improvement.

Almost all recent DoD activities aimed at improving urban capabilities have focused on the first of the above, that is, on single-Service near-term improvements to current methods of tactical operations. Examples include the US Marine Corps' Urban Warrior and Project Metropolis programs; the Army's Combined Arms Military Operations on Urbanized Terrain (MOUT) Task Force; and the Army/Marine Corps/Office of the Secretary of Defense (OSD) MOUT Advanced Concept Technology Demonstration (ACTD). These programs, though vitally needed, have not sought the types of dramatic improvements that may be possible with new approaches that take an operational, vice tactical, perspective. Indeed, the exploration of such approaches will require changing how the Department thinks, organizes, and invests regarding urban operations.

Despite a growing unease that the urban environment is a known vulnerability of US forces, DoD has *not* made a major commitment to dramatically improve urban capabilities. Concerns about this situation have been expressed from both within and outside DoD.[1] However, recent efforts within DoD have begun to explore new approaches to improving current capabilities. Examples at the Joint Force Commander level in particular include the following:

- The Chairman, Joint Chiefs of Staff (CJCS) J8 Dominant Maneuver Assessment Division has served as the focal point for operational-level military assessments regarding joint urban issues for the past five years.

- During that same period of time, the informal Joint Urban Working Group (JUWG) collaborated on, participated in, supervised, and led joint urban assessments and wargames in the areas of joint urban doctrine; urban modeling and simulation (M&S); joint urban capabilities; urban intelligence, surveillance, and reconnaissance (ISR); urban command, control, and communications (C3); and joint urban training and facilities. These assessments identified shortcomings and gaps regarding current, joint, operational-level urban capabilities, and served as the starting point for the development of this Roadmap.

Complementing the Joint Staff efforts have been a number of endeavors, including the following:

- OSD (Policy) has chaired an informal urban working group to share information of interest throughout DoD.

- The Assistant Secretary of Defense (ASD) for Command, Control, Communications, and Intelligence (C3I) has established a Defense Intelligence Urban Working Group to address urban ISR issues.

- In support of a commitment made by the Deputy Secretary of Defense to the US Congress,[2] the Joint Staff (J8) is chairing a flag-level Special Study

---

[1] Defense Planning Guidance, FY-2001; US General Accounting Office, "Focused Attention Needed to Prepare US Forces for Combat in Urban Areas," February 2000; U. S. House of Representatives, Floyd D. Spence National Defense Authorization Act for FY 2001, Committee on Armed Services, Report 106–616, p. 342.

[2] Letter from Deputy Secretary of Defense to Chairman, Subcommittee on Defense, Committee on Appropriations, May 2001.

Group to advise the Secretary regarding the creation of a DoD Executive Agent and the development of a *DoD Master Plan* to address joint urban capabilities.

- A *Handbook for Joint Urban Operations,* drafted by the Air Force, has been approved and distributed by the Joint Staff.[3]

- And, for the first time, joint doctrine for urban operations has been developed.[4]

These DoD efforts are pursuing promising paths, but until a focal point is established with authority and resources to coordinate and advance them, improvements will continue to be evolutionary. And there is hope that significant improvement can be achieved. New approaches—leveraging joint capabilities at the operational level—hold the promise of achieving urban objectives while significantly reducing (but not eliminating) casualties and collateral damage. These approaches are based on new capabilities for understanding and shaping at the operational level *before* engaging, and by engaging with precision effects from less vulnerable positions. These approaches are sparked by emerging technologies but can only be realized through changes in all elements of DOTMLPF (doctrine, organization, training, materiel, leadership, people, facilities).

To help advance these new approaches, the Joint Advanced Warfighting Program (JAWP) at the Institute for Defense Analyses (IDA) was tasked to develop this report, *Department of Defense Roadmap for Improving Capabilities for Joint Urban Operations.* The Roadmap identifies directions to pursue in order to improve dramatically the capabilities of future Joint Force Commanders to conduct military operations involving urban environments.

II. Outline of This Summary

The following sections summarize the results of the Roadmap. (Readers interested in a specific topic can skip ahead to that section in the Summary.) Details are given in the main report.

---

[3] US Department of Defense, *Handbook for Joint Urban Operations*, US Government Printing Office, Washington, DC, 2000.

[4] US Department of Defense, Joint Staff, *Doctrine for Joint Urban Operations*, Joint Publication 3-06, September 2002.

Section III, "New Thinking: the Overarching Concept," describes the overarching operational-level approach in terms of the components Understand, Shape, Engage, Consolidate, and Transition (USECT). Page S–4.

Section IV, "The Roadmap Process," describes the range of urban missions, types of operational concepts, required operational capabilities, capability assessments, current DoD programs and activities, and the "landscape" of needed programs and activities. Page S–5.

Section V, "Key Directions for Initiatives: Operational Capabilities," summarizes the initiatives needed to improve the capabilities in each of the USECT categories. Page S–11.

Section VI, "Key Directions for Initiatives: Supporting Activities," summarizes the programs and activities needed to support the achievement of the above capabilities. These are given in terms of the DOTMLPF categories and categories addressing Policy and Legality, Coalition and Interagency, Concept Development and Experimentation, and Modeling and Simulation. Page S–18.

Section VII, "Summary of the Strawman Program," presents a Strawman Program of initiatives addressing the key directions identified in Sections V and VI, and gives (rough) cost estimates. Page S–25.

Section VIII, "Implementation," discusses DoD actions that are needed in order to realize the Strawman Program. Page S–26.

Section IX, "Conclusion," presents a brief summary and identifies the most critical organizational needs facing DoD. Page S–27.

III. New Thinking: The Overarching Concept

Traditional approaches to urban operations result from the difficulty in acquiring information in an urban environment. Without information regarding the nature, positions, and movements of the enemy force, the friendly force commander must rely on approaches that are static (*siege*), indiscriminate (*rubble-ization*), or which trade casualties for information by sending ground forces blindly forward to establish close contact with the enemy (*frontal assault*).

The draft *Doctrine for Joint Urban Operations* describes an urban operation in terms of five components: Understand, Shape, Engage, Consolidate, and Transition (USECT).[5] Traditional urban operations have emphasized the "Engage" component (us**E**ct) because of the difficulty in gaining information. This is sometimes referred to as an "attritionist" approach to urban operations, and entails high casualties and extensive collateral damage.

Emerging approaches to urban operations are based on gaining a significantly improved understanding of the enemy, the urban area and its inhabitants, and then using this understanding to shape the battlespace, provide key advantages, and enable the projection of precision effects from less vulnerable positions. In this approach the Joint Force Commander (JFC) understands and shapes *before* engaging (**US**ect), and then engages from less vulnerable positions with precision effects and not overwhelming lethal force. Such an approach is becoming feasible because of emerging technologies in sensors, information, unmanned systems, precision guidance, and non-lethal weapons. However, systems based on such technologies must be developed and tested, new operational concepts employing them must be explored through experimentation, and packages of associated DOTMPLF changes must be effected before the promise can become reality. The Roadmap describes directions for this exploration and development.

Efforts to improve urban capabilities must take a two-pronged approach. Since the need for traditional, close-up engagements cannot be eliminated in the foreseeable future, improved capabilities must continue to be sought at that level. On the other hand, improvements in operational-level situation awareness could significantly reduce the number of close-up engagements needed to achieve objectives in urban areas. Improvements could also create dramatically more favorable conditions when such engagements are necessary.

IV. The Roadmap Process

A. Definition and Focus

The Roadmap identifies directions to pursue in order to improve significantly the capabilities of future JFCs to conduct military operations involving urban terrain. The focus of the Roadmap is on a "toolkit" of capabilities that supports a range of operational concepts so that a future JFC can tailor an approach for any specific situation.

---

[5] US Department of Defense, Joint Staff, *Doctrine for Joint Urban Operations*, Joint Publication 3-06, 2002.

By taking the perspective of a future JFC, the Roadmap focuses on the joint operational level. However, strategic and tactical levels are also considered. The strategic level determines the context and initial conditions, the resources and methods available to the JFC, and the nature of the desired end state. Likewise, tactical capabilities are the building blocks of operational capabilities, and dramatic improvements at the operational level can depend on advances at the tactical level.

The process of developing a Roadmap starts with the overarching concept as described in the previous section, and the output of the process is a program of initiatives that can provide the JFC with capabilities that realize the overarching concept. This process is outlined in Table S–1 below.

Table S–1. Roadmap Process

1. Articulate the **overarching concept**	5. Determine the **capabilities** required to enable the operational concepts
2. Describe the range of urban **missions**	6. Assess the **status** of those capabilities
3. Describe the range of conditions that may prevail for a given mission	7. Review **current programs** aimed at improving the status
4. Identify alternative **operational concepts** for executing the missions	8. Identify gaps and **directions** for program initiatives

B. Missions

Table S–2 lists the types of urban missions that may be assigned to a JFC. These are characterized in terms of the objectives of the missions, which may range from capturing an urban area through peace operations.

Table S–2. Types of Urban Missions

Objective is the urban area itself:
- Capture
- Defend
- Isolate/neutralize

Objective is within an urban area:
- Neutralize an enemy force
- Conduct focused offense (e.g., against a facility; includes generation of “effects” against utilities, information, mobility)
- Conduct focused defense (e.g., create a sanctuary or conduct a rescue operation)

Objective is to protect or assist people in an urban area:
- Neutralize combatants (e.g., peace operation)
- Provide humanitarian assistance
- Provide civil support in the United States

C. Conditions

The severity of the conditions under which a mission can be accomplished is a measure of a JFC's capabilities. The range of such conditions is illustrated in Figure S–1 below, using as an example the Mogadishu operations of 1992 and 1993. This figure shows 12 axes corresponding to different types of conditions. The distance from the origin on each axis represents the degree of difficulty associated with a given condition. A scenario is represented by a polygon that intersects each axis. The "scale" used may be quantitative (e.g., size) but more often will be qualitative (e.g., "attitude of civilians" ranging from "very friendly" to "very hostile"). In the Mogadishu example, the increasingly hostile attitude of civilians, the increasing level of conflict, and the resultant increase in Blue political hesitancy were critical conditions that changed between the 1992 and 1993 phases.

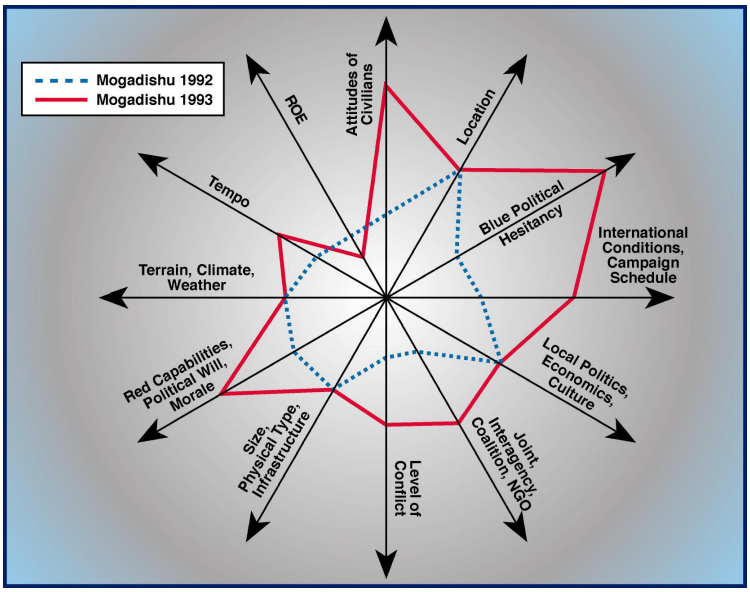

Figure S–1. Types of Urban Missions

In general, the challenge is to develop capabilities that will enable a future JFC to handle those missions and conditions that correspond to likely, realistic scenarios.

D. Operational Concepts

There are three general approaches that a JFC might take regarding the use of ground forces in an urban operation: Standoff Engagement (e.g., siege or remote strike); Temporary Ground-Force Presence (e.g., a raid or Noncombatant Evacuation Operation

(NEO)); and Sustained Ground-Force Presence (e.g., capture an area or peacekeeping). These approaches may be used singly or in combination.

Each of these approaches applies to a different set of the missions and conditions listed in Table S–2 and Figure S–1, and each requires different sets of capabilities for its success. As the extent of ground-force presence in an urban area increases, so does the range of missions that can be performed and the number of capabilities that are required. In general, the required capabilities are "nested": those that support Standoff Engagement also support Temporary Ground-Force Presence and those that support Temporary Ground-Force Presence also support Sustained Ground-Force Presence. This "nesting" can be used to help prioritize development efforts. The Roadmap addresses all three approaches.

To identify required capabilities, the Roadmap process begins with a particularly challenging mission (CAPTURE AN URBAN AREA), and identifies a range of notional operational concepts (both traditional and emerging) that a JFC might employ. These concepts are listed in Figure S–2 below.

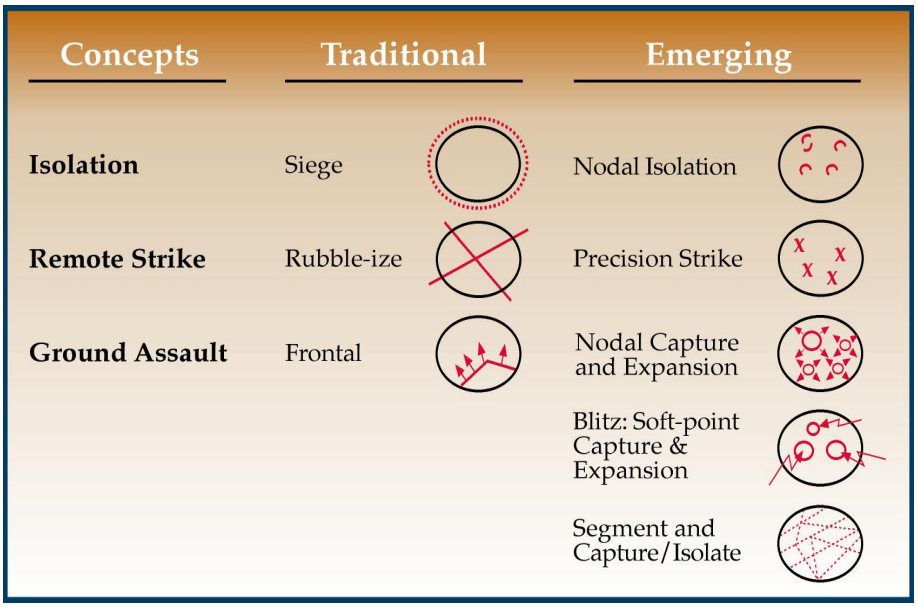

Figure S–2. Types of Operational Concepts (CAPTURE AN URBAN AREA)

Three of the concepts correspond to traditional approaches to capturing a city: *Siege, Rubble-ize*, and *Frontal Assault*. Such approaches are driven by an inability to gain understanding in an urban environment. These approaches either (1) avoid entering the city (*Rubble-ize* or *Siege*) or (2) enter the city with ground forces and gain understanding of

enemy positions and capabilities by establishing close contact (and then respond with overwhelming lethal force). Under most conditions all three approaches will result in high levels of civilian casualties. *Rubble-ize* and *Frontal Assault* will also result in extensive collateral damage, and *Frontal Assault* generally results in high friendly casualties as well.

The five emerging operational concepts are more surgical and offer the prospect of significantly reducing both friendly and civilian casualties, and collateral damage. They may also take less time and involve a more economical use of Blue forces than the traditional alternatives. However, they also require greatly improved capabilities for achieving situation awareness *before* engaging. A central focus of the Roadmap is to determine whether the needed levels of understanding can be achieved.

E. Capabilities

Next, the urban-specific capabilities that enable the operational concepts for the CAPTURE AN URBAN AREA mission are identified. Thirty-one basic capabilities emerge from this process (detailed in Volume II of the Roadmap), and are grouped into categories according to the "USECT" scheme shown in Table S-3 (below).[6]

Table S-3. Urban Capabilities Within USECT Categories

- **Understand Component**
  - Strategic Setting
  - Physical Environment
  - Population
  - Red Forces
  - Blue Forces
- **Shape Component**
  - Strategic Setting
  - Physical Environment
  - Population
  - Red Forces
  - Blue Forces
- **Engage Component**
  - Weapon Delivery
  - Weapon Effects
  - Information Ops, Psyops
- **Consolidate Component**
  - Security
  - Support of Civilians
  - Infrastructure Repair
- **Transition Component**
  - Civilian authority

The remaining missions are then considered, and it turns out that the capabilities required for the CAPTURE AN URBAN AREA mission are also sufficient for the other, less demanding, missions. (See Volume II, Appendix D of the Roadmap for details.)

[6] See Chapter III of this volume.

This process of identifying needed capabilities is summarized and illustrated in Figure S–3 (below).

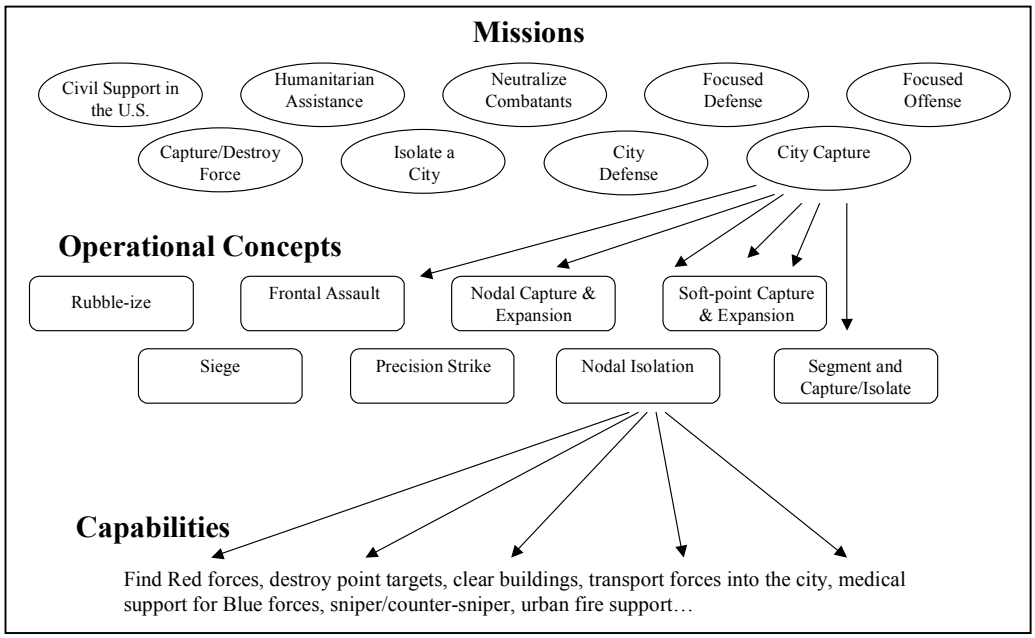

Figure S–3. Mission – Operational Concept – Capability Relationship

F. Status

In general, for *all* of these categories, current capabilities are assessed as being either *poor* or *fair* with significant shortfalls. These assessments are based on recent DoD studies, meetings, workshops, a review of the recent open literature, and comments of reviewers. See Volume II for details about these assessments.

G. Current Programs and Activities

Next, current DoD programs and activities addressing urban capabilities are reviewed. See Chapter IV and Appendix A for timelines of activities in each USECT category and brief program descriptions, respectively. In general, recent and current programs and activities emphasize single-Service capabilities at the tactical level with near- to mid-term goals for force introduction.

H. Directions

The "landscape" of new programs and activities is illustrated in Table S–4 (on the next page). The USECT categories of capabilities in the first column are taken from Table S-3 (page S–9), and initiatives that can produce the desired capabilities are characterized

according to DOTMLPF categories plus categories addressing Policy and Legality, Coalition and Interagency, Concept Development and Experimentation, and Modeling and Simulation. This scheme enables proposals to be related to the capabilities they support, and for gaps to be identified. Key directions for initiatives in each of these categories are described in Sections V and VI that follow.

Table S–4. Landscape of Initiatives for Improving Urban Capabilities

Operational Capabilities	Doctrine	Organiza-tion	Training	Materiel	Leader-ship	People	Facilities	Policy & Legality	Coalition & Inter-agency	Concept Dev. & Exp.	M&S
▶ Understand											
❑ Strategic Setting											
❑ Physical Environment											
❑ Population											
❑ Red Forces											
❑ Blue Forces											
▶ Shape											
❑ Strategic Setting											
❑ Physical Environment											
❑ Population											
❑ Red Forces											
❑ Blue Forces											
▶ Engage											
❑ Weapon Delivery											
❑ Weapon Effects											
❑ Information Ops, Psyops											
▶ Consolidate											
❑ Security											
❑ Support of Civilians											
❑ Infrastructure Repair											
▶ Transition											
❑ Civilian authority											

V. Key Directions for Initiatives: Operational Capabilities

Using the process described in Section IV, the Roadmap identifies directions for initiatives. Highlights of these are summarized in this section in terms of operational capabilities (using the USECT scheme), and in Section VI (starting on page S–18) in terms of supporting activities (using the DOTMLPF scheme).

The program described here is intended as a strawman to stimulate and focus subsequent discussion. It emphasizes high-payoff directions. It is *not* based on detailed proposals, and therefore gives only ball-park cost estimates based on rough comparisons to analogous programs.

Since the approaches and systems identified have not been proven, the Strawman Program focuses on development, not acquisition. The total cost indicates the level of effort required if the Department decides to make a major commitment to dramatically improve urban capabilities.

A. Understand

Physical Environment. Understanding the physical environment provides the backdrop for understanding the positions and movements of Red forces and developing plans for shaping and engaging.

Challenges

- Three-dimensional maps of urban areas, including subterranean structures, interiors of key buildings, infrastructure systems, and activity levels.
- Timely gathering, processing, tailoring, and distribution of results to all levels.

Directions

- Rapid techniques for mining existing data sources.
- Rapid, focusable data-gathering systems and processes, including sensors, platforms, processing, and distribution.

Program

- Explore existing activities and commit additional urban-specific development funds (~$20 million/year).

Red Forces

Challenges

- The central challenges faced by the new approaches to urban operations are determining Red locations, critical points, movements, and status, and distinguishing Red from friends and neutrals.

Directions

- Sensors that can function in an urban environment, such as networked short-range sensors, staring sensors, through-wall sensors, and sensors that employ tagging techniques.
- Platforms to position or carry sensors.
- Data fusion techniques to create an integrated picture of Red forces from independent, possibly disparate, sources of information.

- Systems for leveraging the noncombatant population, especially when the population is friendly, such as secure wireless communications for providing a "neighborhood watch on steroids."

Program

- Explore existing activities and commit additional urban-specific development funds (~$50 million/year, based on four sensor programs, four platform programs, one data fusion program, and one program aimed at leveraging civilians, and an estimate of $5 million/year per program).

Blue Forces. The complexity of the urban environment and the pace of conflict there create a high demand for detailed, timely information. In addition, structures create "dead zones" in communications coverage.

Challenge

- Reliable, secure, high-bandwidth command, control, and communications (C3) in the urban environment.

Directions

- Establishment of local, wide-bandwidth, wireless C3 networks linked to higher levels, e.g., using land or air-based transceivers.

Program

- Explore existing defense and commercial programs and commit additional development funds (~$5 million/year).

Strategic Background, Motivation, and Thinking of Red, Allies, and Noncombatants

Challenge

- The urban environment places high demands on the "operational art" of the JFC, particularly in less-than-full-scale-war operations where tensions among strategic objectives, operational constraints, and coalition-building tend to be high.

Directions

- Leader development to enable future JFCs to be comfortable in complex multinational roles.
- Organizational structures and procedures for effective reach-back capabilities that would allow the JFC to efficiently access expertise from DoD, interagency, multinational, and non-governmental organization (NGO) sources.

Program

- Leader development is addressed in Section VI on page S–22.
- Develop JFC reach-back capabilities (~$5 million/year).

B. Shape

Shaping capabilities enable the JFC to act upon the understanding developed above to enhance his position and degrade Red's.

Restrict Red Options

Challenges

- Control or destruction of Red's critical assets.
- Isolation or segmentation of the Red force by restricting the mobility of Red vehicles and personnel (especially *before* Blue engages with substantial ground forces).
- Control of Red information and psychological environment.

Directions

- Shaping actions that restrict Red options are based on the *coordination* of capabilities to first understand and then engage with the appropriate effects. Those capabilities are addressed above in the Understand section (page S–12) and below in the Engage section (page S–16). The ability to combine these capabilities to produce effective shaping actions depends ultimately on the operational art of the commander, and therefore on developments in the non-materiel aspects of DOTMLPF.

Program

- Initiate concept development and experimentation programs that address new approaches to shaping actions in an urban environment at the operational level. These would exploit emerging technical capabilities for understanding, C3, engaging with precision effects, information operations, and psychological operations ($5 million/year).

Expand Blue Options. Blue's information environment was addressed previously in the Understand section (page S–12). Here the focus is on the protection, mobility, and support of forces in an urban environment.

Challenges

- Providing force protection in an environment where Blue may have to operate within Red's sensor and attack ranges, and Red may have the advantage of protected positions.
- Aircraft, ground vehicles and personnel all face mobility challenges in urban terrain, where structures and obstacles are compounded by close-up threats.
- Regarding support functions, challenges to force protection and mobility are compounded by the high consumption and casualty rates typical of urban operations.

Directions: Protection

- Development of unmanned systems for detection, targeting, engaging, and support functions. Such systems may be air or ground based, stationary or mobile. They may span a range of sizes from the nanoscale to large vehicles, and may be tailored for the urban environment (e.g., stealth, ability to penetrate urban features such as pipes, or perch on structures.)
- Development of systems for the protection of personnel including lightweight ballistic protection, systems that detect and neutralize mines and booby traps, counter-sniper systems, and nuclear-biological-chemical (NBC) detection and protection systems.

Directions: Mobility

- Improvement of the urban survivability of ground vehicles and rotary wing aircraft.
- Improvement of the urban mobility of individual personnel (e.g., exoskeletons).

Directions: Support

- Development of unmanned support systems; precision delivery.
- Development of systems for monitoring medical status, providing remote care, or evacuating casualties within the urban environment.

Program

- Develop programs in each of the above three areas (each about the size of the MOUT ACTD program; see Appendix A for details) (~$50 million/year).

Influencing and Controlling the Strategic Background and the Noncombatant Population

Challenge

- To influence the strategic environment to Blue's advantage.

Directions

- Information systems that control and exploit existing infrastructure such as local television or radio stations; secure cellular communications; automatic translation devices; rapidly assembled shelter and care facilities; and means of planning and conducting psychological operations to empower and support friendly civilians while diminishing Red's effectiveness.
- Organizational structures that enable Blue commanders to better integrate with US agencies, multinational partners, and NGOs.

Program

- Directions addressed by programs under the Understand, Engage, and Consolidate sections.

C. Engage

Weapon Delivery

Challenges

- Rapid response to time-critical targets; precision attack where structures may interfere with trajectories or approaches; three-dimensional targeting; moving targets; underground targets.

Directions

- Target tracking/tagging; rapid C3 and quick-response weapons with autonomous redetection capabilities (such as loitering weapons) for time-critical targets; variable-trajectories for difficult-to-reach aim points; penetrating warheads for underground targets.

Program

- Explore ongoing activities and commit urban-specific development funds (~$20 million/year).

Weapon Effects

Challenges

- Generating the desired effects while reducing noncombatant casualties and collateral damage.
- Determining post-attack effectiveness.

Directions

- Warheads with reduced kinetic effects; thermo-baric weapons.

- Non-lethal effects including directed-energy weapons (both electro-magnetic and acoustic) to control personnel or disable vehicles and other electronic systems; chemical agents (such as calmatives) to clear buildings or to engage an enemy who is among noncombatants; soft projectiles; obstacles; sticky or slippery foams; anti-vehicular traps.

Program

- Initiate an urban-specific kinetic effects program (~$10 million/year).
- Initiate an urban-specific non-lethal effects program that leverages current Joint Non-lethal Weapons Directorate efforts (~$20 million/year).

Information Operations, Psychological Operations. The urban environment is information- and people-intensive, and therefore heightens the importance of information and psychological operations.

Challenges

- Conducting effective information operations and determining post-attack effectiveness.
- Conducting effective psychological operations.

Directions

- Developing technical tools of information operations.
- Achieving knowledge of Red's information-based systems.
- Developing technical capabilities and cultural understanding for psychological operations.

Program

- Explore ongoing activities and commit urban-specific development funds (~$10 million/year).

D. Consolidate and Transition

Challenges

- Number of forces required to maintain security of an urban area.
- Restoration of basic services to the population.
- Restore rule of law and transition to stable government.

Directions. Many areas relevant to Consolidate and Transition have already been addressed, such as non-lethal systems for security and crowd control, autonomous sen-

sors and weapons for sentries or patrols, and reach-back capabilities for access to expertise. Other relevant areas include

- Systems that support the restoration of infrastructure (such as water, power, and transportation) and that provide for the basic needs of the population (food, shelter, and medical).
- Organizational approaches that enable combat forces to hand off the Consolidate and Transition phases to specialized units. Such units may also be employed for peacekeeping and humanitarian assistance missions in lesser contingencies.

Program

- Explore current activities addressing restoration of infrastructure and services, and commit development funds (~$10 million/year).
- Assess alternatives for forming "consolidation" forces and civil affairs units (including Active/Reserve mix). (The cost of this program is included under "Organization" on page S–19.)

VI. Key Directions for Initiatives: Supporting Activities

The above capabilities can only be realized through coordinated "packages" of changes in DOTMLPF and categories addressing Policy and Legality, Coalition and Interagency, Concept Development and Experimentation, and Modeling and Simulation. This section summarizes some of the key challenges and directions in each of these supporting areas.

A. Doctrine

Doctrine forms the basis from which urban operations are planned and executed: it is the glue that links current military capabilities to methods of employment.

Challenges

- There is currently no effective, adaptive process for the maintenance and revision of joint urban doctrine based on exercises and real-world experience.
- There is no interagency doctrine for urban operations.
- There is no multinational doctrine for urban operations.

Program

- Expand current Service and Joint Staff efforts to enhance organizational support and increase resources for the development and maintenance of joint, interagency, and multi-national urban doctrine.

- Create an active joint center for urban "lessons learned."
- Develop doctrine for interagency and multinational urban operations.

Total: ~$1 million/year.

B. Organization

Challenges. The design of forces for urban operations raises key organizational issues, among them:

- Alternative organizational structures for distributed joint urban combat operations.
- Specialized units for urban combat operations.
- Specialized units and organizational arrangements with non-military agencies (including NGOs) for the Consolidate and Transition components of an urban operation, and more generally, for urban humanitarian assistance and peacekeeping missions.
- The appropriate Active/Reserve mix for non-combat units.

Program

- Initiate concept development and experimentation program for new combat organizations.
- Conduct studies and analyses of different organizational approaches to post-combat or non-combat roles.

Total: ~$1 million/year.

C. Training, People, and Facilities

Training for urban operations encompasses Service core training, interoperability training, and joint task force training.

Challenges

- There are no interoperability or joint urban training requirements.
- There are no urban-related recruiting, selection, or training standards.
- Training facilities cannot effectively handle large units (battalion and above), combined arms, joint forces, multinational forces, or operational-level considerations. They are generally not networked to other facilities; they lack likely modern features such as infrastructure; they are not populated; they do not include di-

verse features such as high-rises or subterranean structures; and they are not adequately instrumented.

Program

- Define urban skills; establish training standards for individual personnel.
- Establish joint training requirements; plan joint/interoperable training development.
- Develop a plan for joint training facilities.

Total: ~$5 million/year.

D. Materiel

Materiel developments can spark changes in DOTMLPF leading to major improvements in capabilities. Progress can be made at three levels: science and technology (S&T), systems development, and systems acquisition. Approaches that offer the potential for major improvements in urban capabilities are, in general, unproven and therefore not ready for materiel acquisition. We therefore focus here on system development and S&T.

System Development. Directions for system development were described previously in Section V with regard to achieving specific USECT capabilities. Here we summarize some of the important directions identified.

Directions: Understand

- Automated search/mining of existing databases; 3D mapping.
- Sensors that are effective in an urban environment: networked; staring; activity sensors (e.g., movement, utilities usage); through-wall; tagging.
- Platforms for carrying/deploying sensors and communications assets: air or ground, manned or unmanned.
- Information fusion, processing, display and decision aids.
- Urban C3; position location; reach-back.

Directions: Shape

- Improved systems for information operations.
- Anti-personnel and anti-vehicle barriers.
- Unattended sensor/weapons (lethal and non-lethal).
- Reliable, secure information environment.

- Survivable ground vehicles; survivable rotary wing aircraft.
- Ballistic protection for personnel (and vehicles).
- Chemical/Biological/Radiological protection.
- Counter-sniper systems.
- Mine/Booby trap detection and neutralization.
- Ground force support systems (including medical).
- Unmanned systems (e.g., RSTA (Reconnaissance, Surveillance, and Target Acquisition); engagement; support).

Direction: Engage

- Standoff precision engagement.
- Rapid sensor/ shooter links.
- Variable-trajectory weapons.
- Engaging moving targets and buried targets.
- Reduced-effects kinetic munitions.
- Non-lethal effects (e.g., directed energy, chemical).
- BDA (battle damage assessment) for non-lethal effects.

Directions: Consolidate and Transition

- Sentry systems; barriers.
- Systems enabling the restoration of infrastructure, and civilian support.

Science and Technology. Although generally applicable across all environments, some areas of S&T may address problems that are of special importance to urban environments, such as technologies that enable robots to negotiate stairs or sensors to penetrate walls.

Directions

- Information technologies: rapid mapping, visualization, networks, wide-band wireless communications, decision-support.
- Robotics.
- Sensor technologies.
- Air and ground vehicle technologies.
- Non-lethal effects.
- Miniaturization.

- Materials (e.g., for ballistic protection).
- Exoskeletons.
- Power sources, propulsion.
- Chemical/Biological/Radiological detection and protection.

Program

- Initiate urban-specific S&T development programs (~$20 million).

E. Leadership

Urban conflict presents unique challenges to the JFC due to the complexity of its physical environment, its human dimension, and the likely involvement of interagency, multinational, and NGO interests. The Roadmap focuses on providing a toolkit of capabilities to the JFC, but how effectively those tools are used depends on the JFC's "operational art." Therefore leader development becomes critical.

Challenges

- There are currently no formal programs of instruction to prepare prospective JFCs for urban conflict.

Program

- Create formal urban-specific programs of instruction at the joint, Service, and interagency senior schools.
- Create centers of expertise in Service and joint organizations that could enable an incoming JFC to quickly "get up to speed" regarding the unique demands of urban operations.

Total: ~$1 million/year.

F. Policy and Legality

Current policy and legal agreements were created to deal with conflict by traditional means. Such issues now require reconsideration in light of new approaches to urban conflict.

Challenges

- Several existing policy and legal agreements constrain or prohibit the use of promising approaches to urban operations. These approaches include the use of non-lethal chemical agents, robotic weapons, and certain types of information operations.

Program

- Identify constraining policies or legal agreements, and explore options for either creating operating guidelines that assure compliance, or modifying the policies or legal agreements (~$1 million/year).

G. Coalition, Interagency, and Non-Governmental Organizations

All components of a modern urban operation are likely to require that the JFC interact closely with interagency, multinational, and NGOs.

Challenges

- Communication and coordination between military and interagency, multinational, and NGOs are limited by a lack of established lines of communication, organizational cross-representation, contingency planning, exercise participation, and education.

Program

- Promote communication and coordination between future JFCs and interagency, multinational, and NGOs by implementing organizational changes, means of communication, educational activities, cooperative programs, and combined exercises (~$1 million/year).

H. Concept Development and Experimentation

There are technical risks, operational risks, and cost risks in the proposed new approaches to joint urban operations. Therefore, concept development and experimentation are essential next steps.

Challenges

- Many underlying technologies have to be developed into systems, and these systems need to be demonstrated.
- New operational concepts have to be defined in detail and explored in realistic environments against determined and resourceful opponents.
- Costs of the new approaches have to be determined.

Program

- Coordinated developmental activities addressing these challenges can proceed in parallel. The two key components are (1) system development and demonstration and (2) concept development and experimentation.

All of the tools of concept development and experimentation are relevant:

- Studies, analyses, and constructive simulations.
- Seminars and wargames.
- Human-in-the-loop (HITL) virtual simulations.
- Field exercises.

Initial efforts can be small scale and emphasize the tools at the top of the list. In addition, concept developers can focus Limited-Objective Experiments on key elements of a concept, or dedicate "slices" of larger experimental events to specific urban issues. Later, more extensive HITL simulations and field experiments would be appropriate.

Total: ~$20 million.

I. Modeling and Simulation

Modeling and simulation are essential tools of training, system development, concept development, and experimentation. They also support operational capabilities.

Challenges

- Few models have any MOUT representational capability, particularly at the operational level, and the new, large DoD-sponsored models—such as JSIMS (Joint Simulation and Integrated Modeling System) and JWARS (Joint Warfare Simulation)—have *no* MOUT capability at all.

Program

- Plan and fund improved models for MOUT. Enhance existing models, such as JCATS (Joint Conflict and Tactical Simulation), and incorporate MOUT capabilities in emerging future models. Define and adapt more realistic approaches to the verification, validation, and accreditation of these models.
- Plan and develop digitized databases for urban terrain, interiors, and infrastructure. Represent the dynamic linkages between military operations and the state of the environment (including infrastructure).
- Instrument MOUT sites in order to collect data and develop models for individual human response and small-unit behavior.
- Familiarize managers, trainers, and analysts with the development requirements, proper use, and limitations of models and simulations.

Total: ~$10 million/year.

VII. Summary of the Strawman Program

Table S–5 below summarizes the Strawman Program and Organizational Activities, with Oversight estimated at $5 million/year and a Center of Excellence/Battle Lab at $5 million/year. The total cost of a major DoD commitment to improving capabilities is roughly $300 million/year.

Table S–5. Program Summary (Costs in $M/year)

▶ Understand	**~80**
❑ Physical Environment (data mining, mapping)	~20
❑ Red (sensors, platforms, processing, human intelligence)	~50
❑ Blue (C3, position location)	~5
❑ Strategic Background (reach-back)	~5
▶ Shape	**~55**
❑ Red, Noncombatant (control information, mobility, infrastructure)	~5
❑ Blue (protection, mobility, support)	~50
▶ Engage	**~60**
❑ Delivery (3D precision, speed, variable trajectory, penetrating)	~20
❑ Effects (non-lethal, reduced yield,)	~30
❑ Information Ops, Psychological Ops	~10
▶ Consolidate & Transition	**~10**
❑ Restoration of infrastructure & services, special units	~10
▶ Supporting Activities	**~90**
❑ Doctrine (joint, multinational)	~1
❑ Organization (studies, experimentation)	~1
❑ Training, People, Facilities (joint standards & facilities)	~5
❑ Materiel (S&T) (sensor tech, robotics, non-lethals, information tech.)	~20
❑ Policy and Legality (studies)	~1
❑ Coalition and Interagency (studies)	~1
❑ Concept Development and Experimentation	~50
❑ Leadership (Professional Military Education, centers)	~1
❑ Modeling & Simulation	~10
▶ Organizational Activities	**~10**
❑ Oversight	~5
❑ Center of Excellence and Battle Lab	~5
Total:	**~300 $M/year**

VIII. Implementation

Of course it is one thing to identify promising directions for changes to DOTMLPF, and quite another to actually implement such changes—it has been historically difficult to get support for improving urban capabilities. The following describes four elements of an effective implementation program.

1. **Increase the level of DoD oversight and attention.**

   - Establish a DoD focal point (i.e., an Executive Agent) for urban operations. The Special Study Group for Urban Operations has recommended that Commander, US Joint Forces Command, be the Executive Agent for Joint Urban Operations, starting in January 2003. Once appointed, the Executive Agent will be responsible for maintaining and executing a *DoD Master Plan* for improving capabilities for urban operations.

   - Establish a joint office focusing on urban requirements.

   - Establish points of contact throughout DoD for urban operations (OSD, Joint Staff, Combatant Commanders, Services, Agencies).

2. **Increase the priority and sense of urgency within existing organizations for exploring urban issues.**

   - The intelligence community, defense agencies, the US Joint Forces Command, research and development centers, and other organizations are able to give a higher priority to urban issues within existing funding.

3. **Create a new organization for funding urban initiatives.**

   - For example, the Executive Agent could be funded to develop the Master Plan *and* be given funds to begin execution. Later on, when systems are ready for acquisition, a joint program office may be considered.

4. **Develop non-DoD relationships.**

   - There is considerable overlap in capabilities needed for foreign military operations and for homeland defense. Strong interagency relationships that are focused on urban issues must be created and sustained with non-DoD agencies (e.g., Homeland Defense, Justice, State, Energy, the Central Intelligence Agency).

- Likewise, multinational contacts that are focused on urban issues must be developed, e.g., with NATO and its members.

IX. Conclusion

This document identifies new directions for significantly improving a future JFC's capabilities for conducting urban operations. These directions are based on new thinking and new technologies. The new thinking emerging from the DoD communities looks beyond the single-Service tactical level, and seeks major improvements by leveraging joint capabilities at the operational level. The new technologies hold the promise of enabling the new capabilities if they are accompanied by coordinated packages of changes across all elements of DOTMLPF and other supporting activities.

However, if the pursuit of these new directions is to be effective, DoD will have to change the way it thinks, organizes, and invests regarding urban operations. The most critical organizational needs are to create an Executive Agent for urban operations within DoD, and to bring the urban environment into the mainstream of DoD processes, including requirements, budgeting, system development, concept development, and experimentation.

Volume I: Main Report

I. Introduction

> Although we have learned a lot, we have not yet solved the major problem: how to fight and win…without incurring the high casualties historically associated with urban operations.
>
> — *Urban Warrior Exercise Report*,
> Marine Corps Warfighting Laboratory, 1999[1]

> Today we can win in an urban fight; but with a high price in terms of casualties and infrastructure damage. We do not currently dominate the urban battlespace. Our forces have limited ability to see into it, have limited ability to communicate and move within it, and because of the requirement to limit noncombatant casualties and physical damage, have limited means to shoot into it.
>
> — Draft TRADOC Pamphlet 525-66,
> US Army Training and Doctrine Command, 2000

A. The Nature of Urban Warfare[2]

In March 1999 during the URBAN WARRIOR series of exercises, Marine units suffered 30% to 70% casualties during company-sized operations on urban terrain. Such results are often representative of urban operations, which have historically been characterized by a slower operational-level tempo, higher casualty rates among both combatants and noncombatants, and extensive collateral damage. Heavy casualties are suffered in open urban spaces due to the concealment and protection of the enemy in structures and, once structures are entered, from close-up, room-to-room engagements, booby traps, and difficult, rapid, friend-or-foe decisions. The pace is intense, physical endurance is sharply limited, supplies are both more difficult to deliver and consumed more rapidly, and administering to casualties can quickly become the focal point of activity. Urban areas absorb forces, quickly consuming formations and separating them into small units. The sense of isolation is heightened by short lines of sight, disrupted communications, and the immediacy of the enemy.

For forces on the offensive, no wonder the strong impulse throughout military history has been to avoid fighting inside the city. Siege is one way to do this; standoff "rubble-ization" is another. Siege may work if time is on the attacker's side, if the attacker has enough forces to devote to the task, and if the well-being of the civilians in the city can be ignored.

---

[1] Urban Warrior Advanced Warfighting Experiment (AWE) 12–18 March 1999, Reconstruction and Operations Analysis Report, Marine Corps Warfighting Laboratory, July 1999, p. 3.

[2] The terms "urban" and "city" are taken here to denote any area where structures and people are significant characteristics. It is meant to include built-up areas of any size (cities, towns, villages).

Standoff rubble-ization may drive the enemy out by reducing the city to one that is no longer of use to either side—or to its inhabitants. This is faster than siege and involves fewer forces, but still requires sacrificing the interests of the population. And if the goal is to destroy the opposing force, history shows that such a result may prove elusive even amidst the devastation because the rubble provides additional cover and concealment to the enemy.

For the same reasons, forces on the defensive and, more generally, forces with inferior capabilities in open terrain have sought out the cities, particularly those with sympathetic populations, which can provide concealment, logistical support, and a robust intelligence network.

If fighting inside the city cannot be avoided, the traditional approach is for advancing ground forces to determine enemy positions by establishing contact, and to then locally apply overwhelming lethal force. Against a determined enemy, this approach is marked by a slower operational-level tempo, higher combatant and noncombatant casualties, and a greater degree of devastation. Such are the characteristics of urban warfare as US forces have historically fought it.

Although the devastating experience of trench warfare in World War I was followed by innovations in maneuver during the inter-war period, the devastating experiences of urban warfare during World War II were essentially ignored during the Cold War years. The Cold War focused on national survival through strategic deterrence, and on conventional (and nuclear) combat on the plains of Central Europe. In the few instances when US forces did have to fight in urban areas, such as Hue City during the Tet offensive in 1968, tactics, techniques, and procedures similar to those used during World War II were employed—often with similar results.

B. Current US Approach to Urban Operations

A prevalent view of urban operations within US defense circles is:

- Since the urban environment is so challenging, and since it deprives US forces of many of the advantages they enjoy in open terrain, the United States should avoid conflict in urban areas unless absolutely necessary.

- If it becomes necessary to conduct operations in an urban area, the United States should seek ways to accomplish its objectives while minimizing close combat by ground forces. In the past, blunt-attack rubble-ization was the only such choice, but more recently, US forces have employed remote ISR (intelligence, surveillance, and reconnaissance) and precision strike capabilities to reduce civilian casualties and collateral damage (as in Belgrade in 1999 or Baghdad in 1991).

- Given current capabilities, if a large US ground force enters an urban area, the US commander would expect high friendly casualties, high civilian casualties and extensive collateral damage. Current programs sponsored by the Army, Marine Corps and other DoD organizations are exploring ways to increase survivability and reduce noncombatant casualties and collateral damage by improving equipment, tactics, techniques, and procedures, but the urban environment remains a daunting challenge.

C. Concerns with the Current Approach

Recently, concerns have been expressed[3] about US capabilities for conducting urban operations, among them:

- In the twenty-first century, it is becoming increasingly difficult for US forces to avoid operations in areas where structures and civilians are significant factors[4]

- Not enough is being done to improve *remote ISR* and *strike* capabilities in urban areas; these two capabilities would help reduce the amount of close combat that our ground forces would have to conduct in urban settings.

- Regarding the introduction of ground forces, not enough is being done to explore approaches based on joint capabilities and new operational concepts that have the potential of significantly reducing casualties and collateral damage.

To pursue these new approaches, the Department of Defense (DoD) would have to increase its development efforts and investments aimed at improving capabilities in urban environments. Thus, the relative importance of conflict in the urban environment becomes a key issue.

D. The Importance of the Urban Environment in Twenty-First Century Conflict

How important will urban operations be to US national security interests in the twenty-first century? Proponents of increasing attention to the urban environment make the following points:

---

[3] See, for example, *Defense Planning Guidance, FY-2001*; US General Accounting Office, *Focused Attention Needed to Prepare US Forces for Combat in Urban Areas*, February 2000; U. S. House of Representatives, Floyd D. Spence National Defense Authorization Act for FY 2001, Committee on Armed Services, Report 106–616, p. 342.

[4] Some emerging doctrine (e.g., FM 3-06, FM 3-06.11, MCWP 3-35.3) acknowledges the increasing likelihood of the battlefield being urban.

- Urban areas have always been important focal points of conflicts. They are the political, cultural and economic centers of societies. They contain production and storage facilities, information centers, seaports, airports, ground transportation hubs, access to waterways, etc. And this will be increasingly the case as the world continues to urbanize during the twenty-first century.

- While turning points in historical campaigns often are defined in terms of large cities (Stalingrad, Manila, Seoul, Mogadishu, Grozny), it is also true that smaller population centers have often played significant roles in day-to-day military operations (such as on the Western Front during World War II).[5]

- The spectrum of twenty-first century missions is increasingly likely to involve operations in populated areas. Humanitarian assistance, peacekeeping, peace-making, or noncombatant evacuation operations will occur where the people are, i.e., in cities. Focused offensive operations (such as neutralizing a WMD (weapon of mass destruction) facility without releasing toxic materials) and focused defensive operations (such as creating a temporary sanctuary) will typically occur in populated areas. US forces could also be tasked with helping indigenous forces defend an urban area. Given the sprawl of twenty-first century cities, the isolation of an urban area itself may have to be achieved within the urban environment. And there is also an urban dimension to the anti-access threat—most ports and large airfields are located in or near urban areas.

  All of these missions are not only likely to occur in urban areas but also will require ground forces. Moreover, as the spectrum of likely conflict broadens to include less-than-full-scale war, widely destructive approaches become unacceptable since they run counter to US political objectives, e.g., when the US objective is to return a working city to a friendly population.

- The United States cannot afford for its military to have a major environment as a vulnerability—and therefore a sanctuary for the enemy. To paraphrase an old saying, "If you would have peace in the cities, then prepare for war there."[6]

---

[5] Williamson Murray, *War and Urban Terrain in the Twenty-First Century*, IDA Paper P-3568, Institute for Defense Analyses, Alexandria, Virginia, November 2000. Williamson Murray, "Thinking About Cities and War," *Marine Corps Gazette* (July 2000): pp. 38–40.

[6] The original being *Qui desiderat pacem, praeparet bellum*, "Let him who desires peace, prepare for war." From *De Re Militari* by Flavius Vegetius Renatus.

In light of these points, those who seek to improve urban capabilities ask, "For what environments should US forces be preparing if not one characterized by structures and noncombatants?" The enemy knows US capabilities in the open—he has seen them demonstrated in DESERT STORM. If he can choose the place of battle, he is likely to choose one that constrains such advantages, that emphasizes light forces over heavy, and that increases the complexity of the engagement in terms of terrain and civilian presence. He is likely to choose one that slows the tempo, is casualty-producing and destructive—one that tests US national will. In short, he is likely to choose the city.

E. Significant Improvements in Urban Capabilities Are Possible

The challenges posed by urban operations are daunting, but significant improvements in urban capabilities are becoming possible. These improvements are based on *new thinking* about urban operations, and *new technologies*. The new thinking seeks to achieve operational-level understanding and shaping in an urban environment by exploiting emerging joint capabilities for C4ISR[7] and engagement with precision effects. This is discussed in more detail in Chapter II of this volume.

The new approaches are becoming feasible because of emerging technologies. For example, three key technologies that offer special promise are information technologies (including sensors), non-lethal weapons, and robotics.

- Information technologies provide the foundation for new approaches to urban operations. Capabilities for acquiring, processing, and communicating information in an urban environment are advancing rapidly. For example, through-wall sensors are becoming feasible, and distributed sensors ("sensor webs") can overcome the urban line-of-sight limitations of sensors designed for open terrain. Improved processing power can help to digest the massive amounts of data required to describe complex urban terrain, and improved bandwidth over local communication grids can help get that information to the right place at the right time. Such information coupled with an accurate position location system provides the basis for precision strikes in an urban environment.

- Non-lethal technologies address the need to reduce casualties among civilians and limit collateral damage. Systems based on such technologies include both anti-personnel systems (such as directed-energy weapons or chemical agents) and anti-materiel systems that can, e.g., disable vehicles or block transportation routes. Information operations, such as computer

[7] Command, control, communications, computers, intelligence, surveillance, and reconnaissance.

viruses to disable or control an urban area's infrastructure, are also included in this category.

- Robotic systems directly address the need to reduce friendly casualties while extending human capabilities. Unmanned air or ground systems may be used to deploy sensors, conduct reconnaissance, perform sentry duty, provide logistical support, or conduct assaults. Robotic systems can operate in environments that are hazardous to humans (e.g., in areas that have been attacked by chemical or biological weapons), and go places that may be otherwise inaccessible. Robots can also help mitigate the demand imposed by urban terrain for large numbers of personnel.

Of course, technologies by themselves do not constitute capabilities. They must be developed and effectively integrated into the force through "packages" of changes to Doctrine, Organization, Training, Materiel, Leadership, People, and Facilities (DOTMLPF). In addition, changes to national policy or legal agreements may be required to enable new methods to be utilized (such as unmanned weapons or non-lethal chemical agents). But it is the technologies that can spark change.

F. Plan of This Document

Since the subject of urban operations involves no less than the entire spectrum of US military capabilities applied to the urban environment, the contributors to this document are under no illusion that this document can capture a complete description of the way ahead. Rather, the document focuses first on issues that are unique to the urban environment, and then on directions that offer the potential for dramatic improvement at the operational level. With this general focus, the Roadmap seeks to facilitate a process that will ultimately lead to more specific solutions. It provides a common framework for correlating DoD activities and identifying key directions to pursue.

Chapter II, "New Approaches to Urban Operations," describes an overarching concept that can act as a guide for developing new operational concepts for urban operations. The foundation for this overarching concept is the use of emerging joint capabilities at the operational level to better understand and shape the urban battlespace. With this as background, the focus of the Roadmap is the development of a "toolbox" of capabilities that would support a range of operational concepts and enable a future Joint Force Commander (JFC) to tailor an approach to any specific situation.

Chapter III, "Determining Needed Capabilities and Assessing Status, presents the method used to determine what those capabilities should be and how they might be realized. It first describes the range of urban missions, and then some notional operational concepts that might be used. The method concludes with a general classification scheme for the types of capabilities that support the new operational concepts, and a broad assessment of their current status.

Recent, current, and proposed initiatives are addressed in Chapter IV, "Recent and Current Programs and Activities." The initiatives are presented according to the type of capability they support. Brief summaries are given for various DoD organizations and for some special topics. (More detailed descriptions of each program are given in Appendix A.) The result is a characterization of the progress being made toward improving urban capabilities.

Chapter V, "Directions for Improving Urban Capabilities: Operational Capabilities," describes key directions to pursue in terms of the types of capabilities addressed: Understand, Shape, Engage, Consolidate, and Transition (USECT).

Chapter VI, "Directions for Improving Urban Capabilities: Supporting Activities," describes key directions to pursue in terms of the types of supporting activities. It summarizes the key programs and activities needed to support the achievement of the capabilities identified in Chapter V. These are framed in terms of the DOTMLPF categories and categories addressing Policy and Legality, Coalition and Interagency, Concept Development and Experimentation, and Modeling and Simulation.

Even if the directions to pursue are clear, the implementation of programs that make progress in those directions remains a difficult challenge for the Department. Chapter VII, "Implementing the Roadmap," discusses the problem of implementation and describes key elements of a successful implementation program.

Volume II applies the above process in detail. It starts with the full range of urban missions, selects a particularly challenging one (CAPTURE AN URBAN AREA), identifies a number of notional operational concepts that a JFC might employ, and determines the types of capabilities that the JFC must have in order for the operational concepts to be successful. The results are then extended to the other (less demanding) missions. In this way, a detailed set of capabilities for the future JFC's "toolbox" is determined. The status of these capabilities is then broadly assessed as well as the sensitivity of each capability to various conditions. In addition, extensive references are provided in support of these assessments. The results provide a supporting rationale for the key directions identified in Volume I.

II. New Approach to Urban Operations

Past efforts to improve urban capabilities have focused on the single-Service tactical level since the urban environment tends to reduce an operation to a collection of small-unit, close-up ground engagements. However, raising the perspective from the tactical to the operational focuses attention on the higher-level objectives of the operation and brings *joint capabilities* to center stage. For example, use of *joint ISR assets* can provide an understanding of the enemy force which, when coupled with *joint precision strikes*, could reduce the number of close-up engagements required for mission success.

This chapter describes a new "overarching concept" for urban operations in terms of a five-component approach : Understand, Shape, Engage, Consolidate, and Transition (USECT).[1] This overarching concept can guide the design and development of new operational concepts for specific missions. Key characteristics of the overarching concept are:

- application across the range of military operations (war and military operations other than war);
- increased emphasis on the understanding and shaping functions; and
- a focus on the operational level of war and the application of operational art by a JFC.

"Operational art" means the employment of military forces to attain strategic and/or operational objectives through the design, organization, integration, and conduct of strategies, campaigns, major operations, and battles. Operational art translates the JFC's strategy into operational design, and, ultimately, tactical action, by integrating key activities at all levels of war.[2]

A. Background

Traditional approaches to urban operations (siege, rubble-ization, and frontal assault) have been characterized by firepower solutions, slow and linear progress, significant casualties among friendly forces and noncombatants, and destruction of infrastructure. This has been necessary because of the difficulty in obtaining information in the urban environment. The "default" solution to obtaining information has been to engage with infantry, then adjust the operational objectives based on what is learned. This approach

---

[1] As defined in Draft Joint Publication 3-06, Urban Operations, Chapter II.

[2] Joint Publication 1-02, *Department of Defense Dictionary of Military and Associated Terms*, p. 325.

risks tactical and strategic failure since the levels of casualties and destruction necessary to achieve success could diminish political support both at home and abroad.

The vision for future urban operations is that emerging capabilities incorporating new technologies will enable the JFC to understand and shape the urban battlespace and engage with precision effects. This would give well-equipped and trained forces an advantage over opponents who lack such qualities. Today, US forces "own the night" in open environments by exploiting sensor capabilities. The vision here is that they will "own the city" by virtue of superior capabilities to understand, shape, and engage with precision effects, and then effectively consolidate their gains in order to transition to civilian control.

The emerging approach is best understood by contrasting it with an opposite approach referred to by many as "attrition warfare." Attrition warfare seeks victory by destroying the enemy's material assets through superior firepower and technology. It pits strength against strength, and success is achieved by overpowering the enemy. Attrition warfare is linear, firepower intensive, costly, and insensitive to issues such as collateral damage and displaced populations. The emerging approach, on the other hand, seeks to attack enemy vulnerabilities from a position of advantage rather than straight on. It applies strength against weakness.[3]

While gaining positional advantage is one aspect of the emerging approach, it entails much more. For example, it includes gaining an advantage in tempo as well. Tempo, particularly when operating in an urban environment, does not necessarily mean faster action or activity. Its essence is to *seize the initiative*. So an advantage in tempo may be achieved by aggressive action in terms of movement and fires, or it may be achieved by "slowing" activity, just as a sports team slows the pace by maintaining possession of and controlling the ball in order to "run out the clock."[4] Tempo, then, should be thought of in *relative* terms. The objective is to *control* it.[5]

Ultimately, the emerging approach targets the enemy's ability and will to resist.[6] In doing so, the JFC may achieve victory sooner, with fewer casualties and less damage to urban areas and the population that occupies them.

---

[3] Joint Publication 3-0, *Doctrine for Joint Operations*, p. III–14.

[4] Joint Publication 3-0, *Doctrine for Joint Operations*, p. III–15.

[5] This approach is consistent with a recent Joint Staff effort to operationalize Joint Vision 2020. A proposed working definition of Dominant Maneuver could guide future urban operations: "Dominant Maneuver is the orchestrated application of appropriate capabilities to position elements of the Joint force to gain advantage (temporal, geographic, numerical, psychological, informational, etc). The Joint Force exploits that advantage to produce specified effects to achieve operational objectives." (Joint Staff J-8 JWCA Dominant Maneuver Working Group. Summer, 2001.)

[6] Joint Publication 3-0, *Doctrine for Joint Operations*, p. III–11.

Central to the emerging approach is the recognition that military leaders operate—now and in the future—in an environment fraught with friction, uncertainty, disorder, and violence. Commanders need to understand that the enemy experiences the same environment. JFCs should thrive in such chaos, and should train as they will fight. To gain the advantage, the emerging approach seeks to identify the enemy's source of strength and willpower.[7] Successfully exploiting this understanding to shape the operational campaign can diminish the enemy's ability to fight, and eventually break his will to resist.[8]

B. A Conceptual Framework

A conceptual framework for planning and conducting urban operations can be constructed from the interrelated activities of USECT.[9] Although discussed sequentially in this section, these activities function together in an interdependent, continuous, and simultaneous manner. USECT activities may be sequential or concurrent; they may overlap. The point where one stops and another begins is often difficult to define. In some cases, all five may not be required. For example, in some circumstances, a force commander may conduct Understanding and Shaping activities so effectively, he may be able to shift directly to Transition activities and hand off the operation to follow-on forces or other organizations.

The emerging approach moves the focus from the traditionally predominant Engagement component—reflective of attrition warfare—to the Understand and Shape components. By developing a greater capability to understand and shape the urban battlespace, the JFC can effectively target the enemy's critical vulnerabilities. The overarching precepts for each of these five components are summarized in the following sections.

C. Understand

The need to "understand" is continuous throughout any operation. It is "key" to creating *and maintaining* an advantage in tempo. An enemy would choose to operate in an urban environment to diminish our operational capabilities, largely, our capacity for open-area detection and stand-off strike.

---

[7] Carl Von Clausewitz, *On War*, edited by M. Howard and R. Paret, Harvard University Press, 1984, p. 177.

[8] Joint Publication 3-0, *Doctrine for Joint Operations*, p. III–11.

[9] Joint Publication 3-06, *Joint Urban Operations* (second draft), contains a full discussion of USECT, which is the basis for the remainder of this chapter.

The indigenous population's degree of support for the enemy is a key factor in our capacity to achieve understanding in an enemy-infested urban setting. For example:

- If the enemy is not supported by the noncombatants, our capacity to understand is greatly enhanced due to relatively greater access to information through human intelligence.

- If the population is sympathetic toward the enemy, human intelligence could provide much less information. In these cases, the enemy's center of gravity may be his "hold" on popular support, and the key to unhinging him may be a well-coordinated information campaign to turn indigenous popular opinion toward a more attractive alternative than that offered by the enemy.

- In all cases, diplomatic, economic, and informational efforts can be key. The military instrument is not the only instrument, and may not be the prime one. In any case, *it is never the only instrument of power at work*. Additionally, there will be second- or third-order effects to every military action in urban settings. The consequences of those actions should be considered in the planning process, and the importance of coordinating those actions with our governmental agencies and national and international organizations, (especially in operations short of major theater war) cannot be overstated.

The JFC needs to evaluate the urban battlespace, including the urban triad (man-made and physical terrain, population, and infrastructure), the threat, and his own capabilities to determine the implications for military operations. There may be enemy military troops, criminal gangs, vigilantes, and paramilitary factions operating among the noncombatant population. The situation may be complicated by the presence of international non-military governmental departments and agencies such as intelligence, law enforcement, and other specialized entities. Intelligence Preparation of the Battlespace (IPB) and mission analysis—important elements in planning any operation—are far more complicated in urban operations.

The complexities of urban operations require a thorough understanding of the friendly situation, to include such factors as the units' proficiency in urban operations and the availability of specialized equipment. Throughout the campaign, the force commander and his staff should consider the following questions while keeping in mind the strategic objective:

- Does the force need to enter the urban area at all?

- If so, does the force need to control the entire area, or just a portion of it?

- What operational objectives must be achieved in urban areas to support the overall campaign plan in the attainment of strategic objectives?

- What sequencing of activities and events are needed to achieve the identified operational objectives?
- What resources are required to initiate and sustain these activities and/or events?
- Should we encourage noncombatants to leave the urban area (and plan to take care of them), or encourage them to remain in place?

To answer these questions, joint and multinational forces must have the technical capability and the operational acumen to use multi-source information and intelligence fusion, rapid analysis, and dissemination down to the lowest possible level in the command chain. Commanders must identify all relevant forces, clans, religious groups, etc., their strengths and critical vulnerabilities, and the critical nodes of the urban area that may provide leverage if controlled. The IPB process must also take into account special considerations, such as cultural "mapping" and the location of sites that may pose hazardous material or weapons of mass destruction threats.

Air and space sensors will prove vital in the IPB, as will all the elements of intelligence—human, imagery, signals, open-source, measurement, and signature, as well as counterintelligence. Special operations forces can be used to obtain critical information to undermine an enemy's will or capacity to wage war, and to enhance the capabilities of multinational forces.

IPB must also consider the impact on, and of, noncombatants, whose presence in the urban area may be substantial and dynamic. Determining the ethnic and religious composition of the population and, if possible, their intent to flee or remain in the urban areas (to support or resist the enemy) may prove crucial. Early consideration should be given to the establishment of a Civil-Military Operations Task Force or Civil-Military Operations Center (CMOC) to plan and prepare to deal with noncombatants as well as nongovernmental and international organizations. Human behavior is difficult to control on a mass scale; to do so with people of a different culture under the strains of conflict can be a great challenge. The availability of highly trained individuals who understand the culture and the language of the local population will prove indispensable to commanders at all levels in identifying combatants from noncombatants.

D. Shape

Shaping includes all actions taken to set favorable conditions for Engagement activities to begin.

One part of Shaping is conducting the strategic movement of forces into theater to position units for decisive operations. Depending on the situation and objectives to be

achieved, forcible entry may be required initially, which may immediately present military forces with the challenges of mid-intensity combat urban operations. Establishing refugee camps or sanctuaries for noncombatants, providing safe passage for them, and arranging emergency services may be required.

Another aspect of Shaping is deploying military forces in the appropriate sequence given the situation. Rather than deploying combat forces initially, the force commander may need non-combat arms forces early, such as civil affairs, medical support, and psychological operations units.

Establishing and operating the ISR architecture is critical to Shaping. This should include technological means as well as other capabilities such as human intelligence sources and special operations forces.

Physically isolating the urban area is generally an early element of Shaping. At the operational level, to isolate means cutting the enemy off from the functions he depends on to be effective. Isolation has both an external aspect (i.e., of cutting off outside support) and an internal aspect (i.e., of cutting off mutual support). Isolating the enemy may also mean precluding his retreat. The physical isolation of a large urban area clearly has air, space, and, likely, naval implications for the identification and control of the movement of personnel and equipment.

Isolating the urban area in terms of information is a very desirable part of Shaping. The force commander should have the capability to achieve and sustain information superiority over adversaries. Information going into and out of the urban area should be managed, to include cutting off enemy communications and establishing control of indigenous radio, television, and other media. Importantly, this Information Operations aspect of the campaign plan must be fully integrated with other aspects of operations such as public affairs, civil affairs, and psychological operations. Additionally, it must be coordinated with diplomatic entities (United Nations, NATO, etc.) so that all actions remain consistent with the strategic aim. The presence of legitimate international media and charitable organizations will make this task difficult. If our efforts are properly coordinated, their involvement can multiply our advantage.

Finally, Shaping includes providing a more advantageous environment for friendly combat forces. Examples of capabilities that support shaping include improved personal protection for infantry; capabilities for detecting and neutralizing mines and booby traps; counter-sniper capabilities; survivable ground and air vehicles; logistics systems appropriate for urban terrain; and medical support systems.

E. Engage

Engagement consists of those actions taken by the JFC against a hostile force, a political situation, or natural or humanitarian predicament that will most directly

accomplish the mission. To engage, the commander brings all available capabilities to bear in order to accomplish the operational objectives. Engagement can range from large-scale combat operations in war to humanitarian assistance and disaster relief in military operations other than war. In all cases where we face an enemy, recognition of his centers of gravity and identification of his critical vulnerabilities will be key.

Integration and synchronization of forces and knowledge of rules of engagement are critical when employing weapons in urban areas. Forces must have the flexibility to attack targets located within and under buildings or rubble, and to conduct engagements from air to surface, surface to sub-surface, and vice versa. Precision effects are required to deny the enemy the protection that may be gained from the urban environment. These engagements must provide reasonable certainty of achieving the desired effect on the enemy—but with reduced risk of injury to noncombatants, collateral damage, or fratricide. Special Operations Forces can provide rapid and precise small and large-scale direct action forces that have a unique precision strike capability to operate in the urban environment with minimal collateral damage.[10]

At the operational level of war, engagement often requires the seizure, disruption, control or destruction of critical nodes (power grids, communication centers, etc.) identified during the IPB process. This can involve controlling key terrain or infrastructure, unhinging the enemy's decision cycle, cutting or controlling inter-city and intra-city mobility and communications, triggering an enemy's response, or positioning forces to accomplish another phase of the campaign. The goal is not just movement to positions inside a city but to apply strength against the enemy's weakness, using tempo as a controlling mechanism to shatter his organizational command and cohesion.

F. Consolidate

The focus of consolidation is on protecting what has been gained and retaining the initiative to disorganize the enemy in depth. Consolidation therefore calls for an ongoing process of organizing and strengthening an advantage in tempo (spatial, psychological, informational) over the enemy. Consolidation also requires activities geared at neutralizing bypassed enemy forces and processing prisoners. Civil affairs, public affairs and psychological operations units will continue to be especially critical in this aspect, as will engineering efforts ranging from demolition to repairs to new construction.

Other major challenges are associated with infrastructure collapse, humanitarian assistance, and disaster relief. The JFC must address the multiple tasks of consequence management such as mitigating the effects of a weapon of mass destruction, an accidental or collateral environmental disaster, or an outbreak of disease.

---

[10] Joint Publication 1, Joint Warfare of the US Armed Forces, p. 57.

G. Transition

The goal of military operations in urban areas is to achieve the strategic objective and to transfer routine control over the urban area from the military to local civilian authorities or international organizations. Military forces would be incrementally redeployed while the efforts of civil affairs, public affairs, security, medical, and engineer units continued.

An important aspect of Transition is the coordination and cooperation among the CMOC, NGOs, and international organizations in order to return the urban infrastructure and its inhabitants to local authority. The resettlement of displaced civilians and the reconstitution of national military forces are central to the transition process. Critical to this is maintaining the "rule of law." To ensure safety and security, military forces may conduct training with indigenous or multinational law enforcement organizations. The rate of military redeployment can depend on how quickly those organizations establish an effective presence.

H. Summary

The goal of the emerging approach to urban operations, as described in this chapter, is to achieve objectives with fewer friendly casualties, less collateral damage to urban infrastructure, and reduced harm to the noncombatant population. The interrelated activities of Understand, Shape, Engage, Consolidate, and Transition are the framework upon which the approach is constructed. This approach will enable US forces to function more effectively in the uncertain, chaotic, and fluid urban operating environment.

III. Determining Needed Capabilities and Assessing Status

A. Definition and Focus

1. Definition

The *Department of Defense Roadmap for Improving Capabilities for Joint Urban Operations* identifies directions to pursue in order to improve significantly the capabilities of future JFCs to conduct military operations involving urban environments, i.e., environments characterized by structures, noncombatants, and infrastructure.

2. Focus

The focus of the Roadmap is to identify a "toolkit" of capabilities that supports a range of operational concepts so that a future JFC can tailor an approach to any specific situation. The key challenges are to determine what those capabilities should be and how they might be realized.

3. Key Emphases of the Roadmap

Several key emphases underlie the approach being taken to developing the Roadmap.

- **Operational level perspective.** As discussed above, the driving perspective is that of the future JFC, i.e., the operational level of war. However, it is impossible to separate the operational level of war from the strategic and tactical levels. The strategic level determines the context in which the joint force is there in the first place, sets the conditions under which the mission is to be carried out, and defines the desired end state. Also, strategic-level shaping actions may be essential to operational effectiveness. Likewise, tactical capabilities are fundamental to operational capabilities, and improvements on the operational level must ultimately depend on advances on the tactical level.

- **Joint capabilities.** The focus on the JFC brings joint forces to center stage, and joint capabilities open up key opportunities for improving performance. In most scenarios, ground forces will continue to play a central role in urban operations, but aerospace forces and maritime forces, given the proximity of most urban areas to the coast, offer key opportunities for improving overall capabilities. A key aspect of the new approaches is how to leverage the open-terrain capabilities of air, sea, and ground forces to create advantages in an urban environment. Likewise, the synergy of coalition and interagency capabilities will be increasingly critical to operational effectiveness.

- **New operational concepts.** As discussed in Chapter II, the Roadmap is based on new operational concepts, which are guided by the USECT[1] framework, and their enabling capabilities. In general, these new capabilities will require packages of changes across the full range of Doctrine, Organization, Training, Materiel, Leadership, People, and Facilities (DOTMLPF), not just Materiel. The Roadmap addresses activities and programs in each of these areas, as well as integrating activities.

- **Reduced casualties and collateral damage.** A major theme of the Roadmap is to achieve military objectives with significant reductions in friendly casualties, civilian casualties, and collateral damage.

- **Broad set of timeframes.** The roadmap addresses programs that could lead to fielded improvements in the near-term (5 years), mid-term (5–10 years), and far-term (greater than 10 years). The focus is on the "futurity of current decisions," that is, on actions and programs in the current budget that will affect future capabilities.

- **Focus on key directions.** The Roadmap identifies key directions to be followed in pursuit of significant improvements in capabilities. It is not intended to be a "master plan" that covers all activities related to urban operations; it does not set specific budgets and milestones. Rather, the key directions and priorities expressed in this document provide a foundation for a follow-on master plan.

B. An Illustration of the Roadmap Process

This section illustrates the process and its steps used by the JAWP Roadmap Team to develop the Roadmap. Details are found in Volume II. The steps are as follows:

Step 1. List the general types of urban missions and conditions.

Step 2. For a key mission, describe (broadly) operational concepts that a JFC might use (both traditional and emerging).

Step 3. Identify the capabilities needed to enable each of these concepts.

Step 4. Extend the results to the remaining missions by adding concepts and capabilities as needed.

Step 5. Assess (broadly) the status of the capabilities and identify gaps. Identify sensitivity of capabilities to conditions.

---

[1] Understand, Shape, Engage, Consolidate, Transition.

Step 6. Review recent and current programs and activities aimed at improving urban capabilities.

Step 7. Identify directions that could close the gaps, both by capability (USECT scheme) or by supporting activity (DOTMLPF).

Step 8. Identify approaches to implementation.

There are two key points in this process where innovation plays a central role. The first is the introduction of new operational concepts for carrying out a particular mission (Step 2), and the second is the identification of directions that can produce the capabilities needed to realize the new concepts (Step 7).

1. List the General Types of Urban Missions and Conditions

The list in Table III–1 divides the spectrum of urban missions into nine general categories grouped according to the mission's objective. The degree of difficulty of any of these missions will be driven by the particular conditions surrounding the mission. The robustness of a capability can be measured by its effectiveness across a wide range of conditions. We illustrate the "space" of conditions with the following "spider chart" (Figure III–1).

Table III–1. Types of Urban Missions

Objective is the urban area itself:
- Capture
- Defend
- Isolate/neutralize

Objective is within an urban area:
- Neutralize an enemy force
- Conduct focused offense (e.g., against a facility; includes generation of "effects" against utilities, information, mobility)
- Conduct focused defense (e.g., create a sanctuary or conduct a rescue operation)

Objective is to protect or assist people in an urban area:
- Neutralize combatants (e.g., peace operation)
- Provide humanitarian assistance
- Provide civil support in the United States

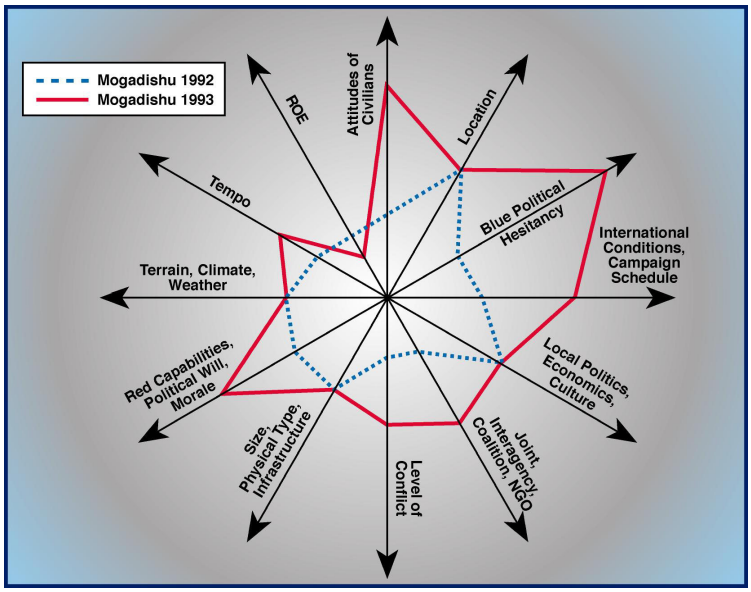

Figure III–1. Conditions Affecting Urban Operations (Mogadishu Examples)

Each "leg" or axis of the chart represents a separate dimension of "condition space," and one can (at least qualitatively) represent the degree of difficulty posed by each condition according to the distance from the origin (at the center of the web)

along its axis. Thus, a specific warfighting scenario may be represented by a polygon that intersects the axes at various distances from the origin. "Easier" cases are close to the origin and more difficult cases are farther out. As an example, Figure III–1 illustrates the changing conditions during two phases of the US involvement in Mogadishu in 1992 and 1993. The attitude of the civilians, the increase in the level of conflict, and the increase in Blue political hesitancy were the driving changes.

Note that the axes are not independent. For example, when the "Attitude of Civilians" is favorable (close to the origin) the Rules of Engagement ("ROE") tend to be more stringent (far from the origin).

These sets of missions and conditions broadly characterize the urban challenges that could be faced by a JFC, and a "toolkit" of capabilities must be designed and developed to enable the JFC to succeed in realistic scenarios.

2. Select a Key Mission and Describe (Broadly) Operational Concepts

Two Guiding Principles

Before discussing the approach used to address operational concepts in the Roadmap process, we describe two guiding principles used to identify potential operational concepts: minimize the amount of close combat required, and focus on understanding and shaping at the operational level.

Minimize the amount of close combat required. The most direct way of achieving the objective while reducing friendly casualties is to minimize the amount of close combat required. We distinguish three levels of ground-force presence: None, Temporary, and Sustained.

- **No ground-force presence.** Examples of "No ground-force presence" include isolation of an urban area, perimeter defense, blockade, or standoff engagement. When applicable, this approach can be effective, but the range of missions and conditions to which it applies is very limited.

- **Temporary ground-force presence.** A number of missions require at least a temporary, "hands-on," ground-force presence. Those cases include focused offensive actions against, e.g., a weapon(s) of mass destruction (WMD) facility (where stand-off destruction could release toxic materials) and noncombatant evacuation operations.

- **Sustained ground-force presence.** Finally, a number of key missions require a sustained ground-force presence. These missions include peace operations, humanitarian assistance, and civil support at the lower levels of conflict; de-

stroying a small hostile force within an urban area at the mid-levels; and capturing or defending an urban area at the highest levels.

Focus on understanding and shaping at the operational level. The application of operational-level Understanding and Shaping to urban operations was described in the last chapter using the USECT scheme. These focal points apply at all levels of conflict and to all levels of ground-force involvement.

Key Example: Capture an Urban Area

We select the mission CAPTURE AN URBAN AREA to exemplify the Roadmap process because it is a particularly challenging mission and the capabilities required to carry it out should also apply to most of the other missions. Here we sketch a few aspects of this case and refer the reader to Volume II for a detailed discussion.

A number of general types of operational concepts that might be employed are listed in Figure III–2. In general, several of these concepts might be used in a given scenario, e.g., in different areas or at different times. We separate them here only to simplify the discussion.

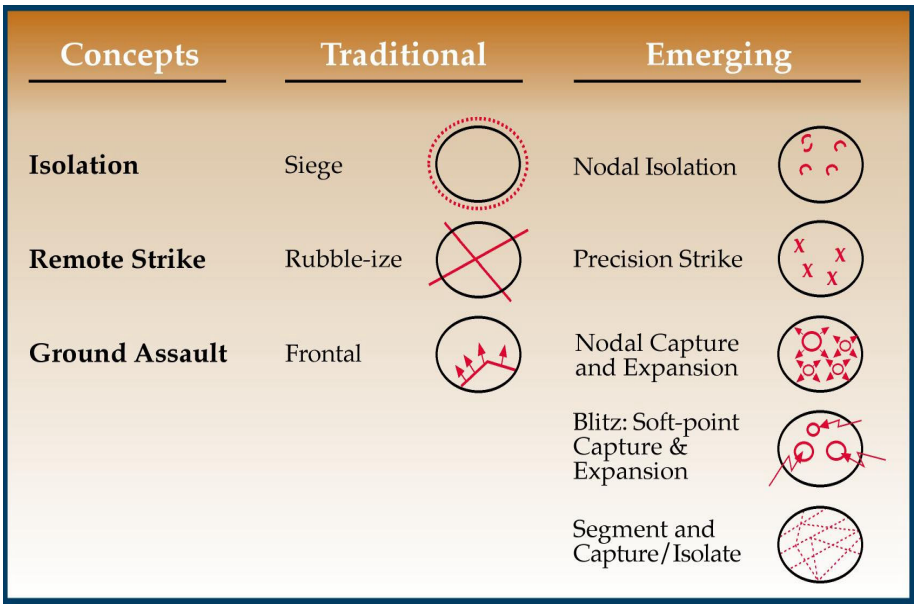

Figure III–2. Some Types of Operational Concepts: Capture an Urban Area

The chart distinguishes the operational concepts according to those that are "traditional" and those that are "emerging" (or "new"). The principal means associated with each concept are listed as **Isolation**, **Remote Strike**, or **Ground Assault**. Isolation and Remote Strike concepts do not require penetration of the urban area by a sizeable ground force whereas the Ground Assault concepts do.

Isolation concepts are aimed at denying Red any advantages of urban occupation. Siege can isolate the Red forces from the rest of a campaign and thereby neutralize

their potential contributions; or, more traditionally, siege can be used to "starve out" the Red forces. Siege requires a willingness to accept the hardships that would befall the civilian population unless it could be evacuated to safety. Depending on the size of the urban area, siege may also require large numbers of forces (50,000 Russian troops were required to isolate Grozny during the second Chechen campaign) and may not be feasible with large, sprawling urban areas. Siege also takes time, and for that reason alone may be precluded in a number of scenarios.

Nodal Isolation is a far-term approach that denies an occupying Red force access to, or use of, critical assets within the city. Elements of this approach may include Information Operations to control facilities such as power stations or communication networks; the creation of "keep-out" zones using remote surveillance, remote generation of precision, non-lethal effects, or deployed robotic sentries; or the similar control of transportation routes and facilities. Again, the idea is to deny the utility of the urban area to a Red occupation force with a minimum of civilian casualties or collateral damage.

Remote Strike concepts employ area or precision strikes to wear down Red forces and deny them advantages that the city provides (e.g., cover, supplies, information, utilities). The city is "captured" when the enemy withdraws. The effectiveness of this concept depends on Blue's willingness to accept civilian casualties and collateral damage, and the level of Red's determination to remain in the city. For example, it may be to Blue's advantage to leave an escape route for Red to encourage withdrawal.

Ground Assault concepts involve forces entering the city. These include frontal sweeps through the city which maintain access—e.g., to supplies—through controlled territory, and the capture of nodes by vertical assault and/or ground penetration and expansion out from those nodes. Nodes could be critical elements of Red defenses or soft points in the Red defenses that could be exploited as a base for subsequent expansion.

Another Ground Assault concept is Segment and Capture/Isolate which uses remote isolation techniques or penetration by ground forces to divide the urban area into segments. Segments that are critical to Red may then become the focal points of subsequent Blue action while sparing less critical areas.

Three of these types of operational concepts correspond to traditional approaches to capturing a city: Siege, Rubble-ize, and Frontal Assault. These approaches are necessitated by the lack of a capability for gaining understanding in an urban environment. One either avoids entering the city (Siege or Rubble-ize) or enters the city with ground forces and gains understanding of enemy positions and capabilities by establishing close contact (and then responding with overwhelming lethal force). Under most conditions all three approaches will result in high levels of civilian casualties. Rubble-ize and Frontal Assault will also result in extensive collateral damage, and Frontal Assault can be expected to result in high friendly casualties as well.

The other five operational concepts are more surgical and offer the prospect of significantly reducing both friendly and civilian casualties, and collateral damage. (They also may be faster and require fewer Blue forces than the traditional alternatives.)

3. Identify the Capabilities Needed to Enable Each of the Concepts

The more surgical operational concepts require a much better understanding of the nature of the city and the enemy forces within it than the traditional approaches. For example, they may require the following:

- the ability to identify nodes either in systems that support the city or key elements of the enemy force;
- the ability to strike those nodes with reduced collateral damage;
- the ability to penetrate with, or vertically deliver, an assault force to interior points of the city and to sustain them there; or
- the ability to isolate sectors of the city.

All of these capabilities may be placed in the general USECT scheme of Draft Joint Publication 3-06, which was described in the previous chapter. Here we summarize the general types of capabilities according to this scheme.

Note that these five components can be applied at every level of an operation to a theater, to a city, or to a building. These components will generally not occur in a linear sequence—they will all take place simultaneously, dynamically, and interactively.

Understand

Understand encompasses the gathering, processing, communicating, and displaying of information regarding all aspects of an urban operation including:

- Strategic Setting
  - Strategic background of mission, desired end-state, roles of allies, agencies, and NGOs
- Physical Environment
  - Structures (e.g., 3D, interiors)
  - Infrastructure and services (e.g., transportation, information, power, water)
- Population
  - Structure (e.g., ethnic, cultural, political, economic, neighborhoods)

  - Capabilities (e.g., human intelligence, skills and services)

- Red Forces
  - Capabilities, motivation, psychology
  - Location, status and movement
  - Intent
  - Support structure

- Blue Forces
  - Location, status

Shape

Shape encompasses both the enhancement of Blue's position and the degradation of Red's. Armed with an understanding of the key factors listed above, the JFC is better able to shape the battlespace to advantage, including:

- Influence Strategic Setting.
  - Through diplomatic, coalition, NGO, interagency efforts

- Control Physical Environment.
  - By controlling movement, infrastructure, services, information

- Influence, Leverage, or Support Noncombatants.

- Restrict Red Options.
  - By countering mobility, controlling information, blocking support, conducting Psychological Operations

- Expand Blue Options.
  - By providing protection, mobility, information, and support

Engage

Engage involves the projection of effects with precision both in location and in intensity, including:

- Weapon Delivery
  - Precision
  - Ability to strike 3D targets amid structures, moving targets, underground targets, targets that are close to noncombatants

- Weapon Effects
  - Lethal or non-lethal
  - Against personnel or materiel
  - Against systems (transportation, information, or infrastructure)
  - Physical, chemical
  - Information Operations, Psychological Operations

Consolidate

Consolidate involves securing captured areas against re-infiltration and restoring infrastructure, law and order, and services. These functions may be provided by separate, non-combat units. Capabilities include:

- Restore security via surveillance, sentries, barriers.
- Provide support to noncombatants.
- Restore infrastructure and services.

Transition

Transition defines the end-point of the operation for the military forces. It includes:

- Return control to civilian authorities.
  - Coordinate with allies, agencies, and NGOs.

4. Extend Results to Other Missions by Adding Capabilities If Needed

This step addresses the remaining missions listed in Table III-1 and their associated operational concepts, identifies the capabilities required by the concepts, and determines whether capabilities in addition to those already identified for the CAPTURE AN URBAN AREA mission are required for the other missions. In working through this process, it was determined that only two additional operational concepts were needed to cover the other missions. However, the 33 capabilities identified for the CAPTURE AN URBAN AREA mission were also adequate for the other missions and operational concepts (see Volume II, Appendix D). The demanding nature of the CAPTURE AN URBAN AREA mission covered a wide enough swath of needed capabilities to include those needed for the other missions. For example, defensive capabilities are addressed in the Consolidate component of the offensive missions, and smaller-scale actions may be addressed using operational concepts and capabilities that are analogous to those that are elements of the larger offensive missions.

5. Assess (Broadly) the Status of the Capabilities and Identify Gaps

Many of the capabilities associated with the more surgical operational concepts require capabilities for understanding, shaping or engaging that go beyond current capabilities under most realistic conditions. The USECT scheme may serve as a framework for focusing assessment and development activity on specific areas. (See the following chapters.)

The assessment of capabilities involves an identification of the conditions under which the capabilities are available. (Various types of conditions are listed in the "spider chart" in Figure III–1 on page III–3.) However, although capabilities are scenario dependent, there are a few general statements that may be made regarding the status of the various types of capabilities. In the following sections, we summarize, using the USECT scheme, the status of capabilities. These assessments were based on reviews of recent studies and assessments, and on consultations with, and reviews by, subject matter experts. For a more detailed discussion, see Volume II.

Understand

New approaches to urban operations require the capabilities to obtain, process, and act upon information in a timely fashion. However, in general, current capabilities for achieving this level of understanding are inadequate.

- **Strategic setting.** As evidenced by the Mogadishu experience, failure to understand the strategic environment can lead to disaster. However, resources that would enable a JFC to rapidly and systematically access expertise on local strategic, political, and cultural forces remain generally inadequate. Likewise, interactions with coalition members and NGOs present unique challenges to the JFC that can erode timeliness and effectiveness. An understanding of the interests and motivations of these organizations is critical, yet current capabilities in this area are rated only "fair."

- **Physical environment.** Current mapping capabilities provide the basis for precision strike against fixed targets in a number of urban environments. However, regions covered are limited; 3-D and interior data is lacking; and abilities to rapidly focus data gathering, processing, and distribution for developing situations are generally inadequate. Also, the timely support of dynamic concepts such as nodal strike and area segmentation, which the new emerging approaches envision, is not generally available. Although advances in the analysis of urban "systems" covering both physical and cultural networks are impressive, continued progress in both coverage and turn-around time is needed to support the new approaches.

- **Population.** The new approaches seek to minimize civilian casualties and leverage the capabilities of friendly factions. This requires, on the one hand, dynamic ISR systems that can keep track of civilian presence, and, on the other hand, abilities to understand the local populace and its likely actions and/or reactions. These capabilities are currently very limited.

- **Red forces.** Current abilities to detect, localize, track, and target Red forces in an urban environment are generally inadequate to support the shaping and precision engagement required by the new approaches.

- **Blue forces.** Abilities to keep track of the location and status of Blue forces are severely restricted by constraints on communications and navigation systems in urban terrain.

Shape

Shaping activities depend on an understanding of Red and Blue positions and status, and the surrounding physical and human environment. As just discussed, current capabilities for achieving that level of understanding are generally inadequate in most urban environments. However, as progress is made in the area of understanding, additional capabilities will be required to enable Blue to capitalize on this progress.

- **Influence strategic setting.** Capabilities for dealing with coalition partners, neutral parties, and NGOs are rated "fair."

- **Control physical environment.** Methods (both destructive and non-destructive) are becoming feasible that would enable Blue to control elements of the infrastructure of an urban area such as transportation systems, information networks, or utilities. However, current capabilities are extremely limited.

- **Influence, leverage, or support noncombatants.** Abilities to communicate with, and influence, the local populace are currently limited. Also, abilities to leverage or empower friendly factions, e.g., for the purposes of gathering intelligence, are generally not systematically developed.

- **Restrict Red options.** Abilities to control Red's environment are key to the new approaches. These include capabilities to erect barriers, or disable vehicles, to control mobility in order to isolate or segment Red forces. Methods for controlling Red's access to information are also included. These may involve the use, control, or disabling of Red's information systems. The psychological dimension is also included in shaping Red's environment. All of these capabilities are currently inadequate to support the kind of shaping operations envisioned by the new approaches.

- **Expand Blue options.** The Blue operating environment in urban areas is currently inadequate to support the new approaches. Blue forces, whether personnel, ground vehicles or aircraft, suffer from increased vulnerability and decreased mobility in an urban environment. Sensors and communications are limited. Support (including medical) is also generally inadequate.

Engage

The focal points of the new approaches are to engage with precision and/or with non-lethal effects.

- **Weapon delivery.** Abilities to conduct broad area attack are good, and capabilities for precision attack against fixed targets where trajectories are not blocked by neighboring structures are also good. However, capabilities for attacking mobile targets, underground targets, or targets that may require a variable-trajectory weapon are limited.

- **Weapon effects.** A number of promising non-lethal weapons are under development but have not yet become operational. Current operational capabilities for projecting non-lethal kinetic effects (e.g., soft projectiles) are extremely limited.[2]

- **Information Operations, Psychological Operations.** Capabilities for conducting Information Operations are rapidly advancing, and current Psychological Operations can be effective if well supported by a base of cultural understanding.

Consolidate

Consolidation takes place in areas that are under Blue control. It stresses defense against incursion by Red, and the restoration of infrastructure and services. A key challenge of this phase is the large number of forces required to secure an urban area.

- **Restore security via surveillance, sentries, barriers.**

- **Provide support to noncombatants.**

- **Restore infrastructure and services.**

---

[2] The Non-Lethal Modular Crowd Control Munition (MCCM), which is used for counter-personnel, is a current operational capability. Additionally, the 40mm NL Crowd Dispersal Cartridge (NLCDC) and the 66mm Vehicle Launched NL Grenades will be operational in 2002.

There are suitable capabilities to address all three areas, but the quantitative aspects could be daunting, particularly if there has been extensive destruction or the use of chemical or biological agents

Transition

- **Return control to civilian authorities.** The transition phase involves the coalition, interagency, and NGO linkages as well as dealing with local political, cultural, and economic issues. Civil affairs and political and/or military affairs are central players. Overall capabilities are rated "fair."

6. Review Recent and Current Programs and Activities

This step is the subject of the next chapter which describes recent and current programs and activities as well as some that are currently being proposed by DoD organizations.

7. Identify Directions That Could Close the Gaps, Both by Capability (USECT scheme) or by Supporting Activity (DOTMLPF scheme)

These directions are the results of the Roadmap process and are the subjects of Chapters V (USECT scheme) and VI (DOTMLPF scheme). For examples: Certain intelligence programs are improving the availability and detail of information about the physical urban environment, including 3-D maps and infrastructure. Programs aimed at developing non-lethal weapons could significantly reduce undesired consequences of strike operations, or provide the basis for isolation techniques. Programs aimed at defending rotary-wing aircraft in an urban environment are critical to vertical assault capabilities. And experimentation programs focused on concepts and capabilities for conducting urban operations are essential if progress is to be made.

8. Identify Approaches to Implementation

This is the subject of Chapter VII.

IV. Recent and Current Programs and Activities

The previous chapter described types of capabilities that are needed to support new approaches to urban operations and discussed the current status of those capabilities. In general, current capabilities cannot support the new approaches, but there are promising directions that could lead to the needed capabilities. This chapter describes the general "landscape" of programs and activities that are aimed at improving urban capabilities, and shows where recent, current, and proposed DoD activities fit on the landscape. Various components of the landscape are then discussed separately.

A. Landscape of Programs and Activities

We describe the landscape of programs and activities aimed at improving urban capabilities in terms of the matrix (depicted in Table IV–1 on the next page). The rows identify the types of capabilities in terms of the USECT scheme. The columns identify types of activities that could produce the capabilities. The columns follow the DOTMLPF scheme for identifying the focal points of change, and other categories that cut across all types of capabilities are incorporated as well" Policy and Legality, Coalition and Interagency, Concept Development and Experimentation, and Modeling and Simulation (M&S). For example, Policy and Legality will play a central role in establishing whether certain unmanned or non-lethal weapons (NLW) can be developed; Concept Development and Experimentation will play central roles in developing and integrating the new capabilities; and Modeling and Simulation provides basic tools for making advances in several of the other areas.

An activity may correspond to a single entry in the matrix. (For example, the development of a new sensor would correspond to the "Material" column and "Understand – Red Forces" row.) Or, an activity may correspond to a whole row (e.g., the Joint Non-Lethal Weapons Program would correspond to "Engage" in "Weapon Effects"), to a whole column (e.g., the development of joint doctrine for urban operations), or to several rows and columns. (For example, a program aimed at developing effective coalition and interagency communications could impact rows under Understand, Shape, Consolidate, and Transition, and several of the other columns.)

Table IV–1. Landscape of Initiatives for Improving Urban Capabilities

Operational Capabilities	Doctrine	Organization	Training	Materiel	Leadership	People	Facilities	Policy & Legality	Coalition & Interagency	Concept Dev. & Exp.	M&S
▶ Understand											
❑ Strategic Setting											
❑ Physical Environment											
❑ Population											
❑ Red Forces											
❑ Blue Forces											
▶ Shape											
❑ Strategic Setting											
❑ Physical Environment											
❑ Population											
❑ Red Forces											
❑ Blue Forces											
▶ Engage											
❑ Weapon Delivery											
❑ Weapon Effects											
❑ Information Ops, Psyops											
▶ Consolidate											
❑ Security											
❑ Support of Civilians											
❑ Infrastructure Repair											
▶ Transition											
❑ Civilian authority											

Note that there are overlaps between categories. For example, a program aimed at developing a device that generates a non-lethal effect would be in the "Materiel" column but could go in either the "Engage" or "Shape" row. Or the development of a MOUT training facility could go either under "Training" or "Facility." It is better to have overlaps than have categories that miss programs entirely.

B. Sub-Roadmaps

We use the matrix in Table IV–1 to identify and relate "sub-roadmaps" that are components of the overall roadmap. Each of these sub-roadmaps may have a separate "development effort" that contributes to the overall effort. Sub-roadmaps may correspond to various parts of the matrix: elements, rows, columns. Along the rows, we will consider each component of USECT, and look at the programs and activities across DOTMLPF that address that component. In this way we will determine the effort for each component. These could be large components, such as "Shape – Protect Blue Forces," or smaller elements, such as "Protection of Rotary-Wing Aircraft."

Sub-roadmaps can also be vertical, that is, corresponding to the columns of the matrix. For example, sub-roadmaps may address the development of joint doctrine for urban operations, or the development of urban M&S tools.

Another way to categorize the activities is according to the principal sponsor of the activity. Here, too, one may construct the effort that traces the development activities of various organizations within DoD (or elsewhere). Brief summaries for several DoD organizations are given later in this chapter (Section F on page 13) and some specific topics (ground vehicles, medical support, and robotics) are discussed in more detail in Appendix B of this volume. This breakdown also allows us to link the roadmap developed here to roadmaps for component areas developed by other organizations such as the Urban Science and Technology Roadmap developed as one of the Joint Warfighting Capabilities Objectives by the Office of the Under Secretary of Defense for Science and Technology (OUSD(S&T)). This particular Roadmap is discussed in detail in Volume II, Appendix A. Also discussed is the roadmap developed by the Defense Intelligence Urban Working Group.

Given the complexity of the subject, we cannot hope to cover the complete landscape in all detail. As discussed previously, we will focus on those activities that are critical to the development of new approaches that offer significantly improved performance at the operational level. This also implies an emphasis on activities that address mid- or far-term capabilities rather than incremental improvements to current capabilities.

C. Sub-Roadmaps: USECT

The following figures depict urban-related activities across DoD. The first five figures depict activities that are relevant to specific urban capabilities of the US military. These activities are categorized using the USECT scheme. Some of the activities are listed in more than one figure to reflect their relevance to different facets of MOUT. Activities with multiple listings are marked with an asterisk. Each activity is listed by name, primary sponsor, effective dates, and symbols to denote outlook (near-, mid-,far-term). For more detail on any of these activities, refer to Appendix A in this volume. Each program is listed there under the section for its respective sponsor. The tick marks on the timelines refer to the approximate start of the activity. The dates in parentheses refer to the duration of the effort. Arrows from the left edge of the figure denote activities that predate the beginning of the timeline. A list of some of the activities that have been proposed by DoD organizations is included at the end of each section.

The last two figures depict those activities deemed as supporting improvements in MOUT capabilities but in a more indirect manner. The sub-categories for these figures use elements of the DOTMLPF scheme and other related categories. A list of some activities proposed by DoD organizations follows the text.

1. Understand

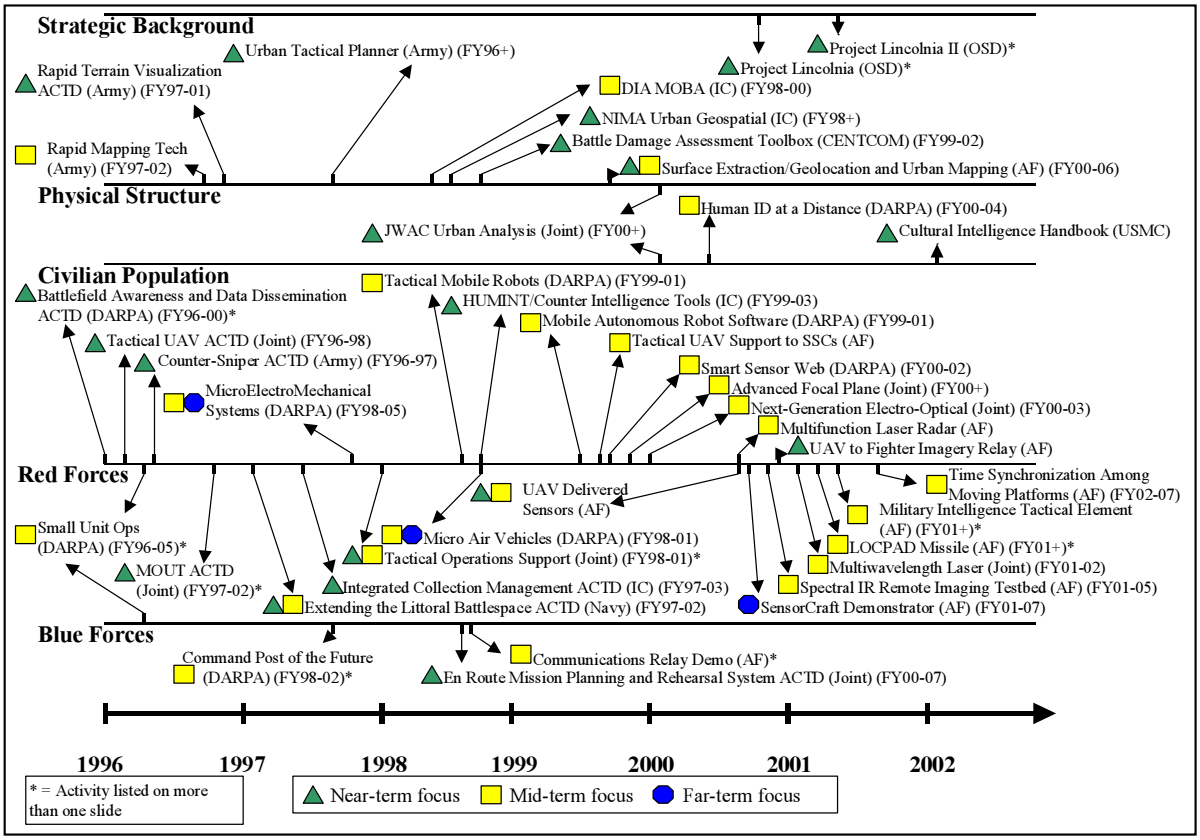

Figure IV–1. MOUT Activities: Understand

The preponderance of the efforts related to understanding the urban environment focus on Red. These activities cover a range of topics, including advanced sensors, sensor delivery vehicles, and sensor integration. However, they are similar in their targeting of Red.

Conversely, relatively few activities focus on understanding the integration of a city's infrastructure or the nuances of the civilian population. The Joint Warfare Analysis Center's (JWAC) nodal analysis of both urban infrastructures and civilian populations stands out as the only effort addressing those two areas. Several efforts look at mapping the urban terrain, and in particular, at collection, databases, and dissemination issues. A smaller number of efforts are targeted on understanding Blue. Given the problems associated with urban command and control, this is an area in need of more attention.

Most of the activities across Understand take a tactical perspective. Coverage of the operational and strategic levels of warfare is thin, especially the area of strategic back-

ground. PROJECT LINCOLNIA and LINCOLNIA II are rare in their attention to the strategic context.

In sum, the bulk of the activities related to Understand are aimed at finding materiel solutions for conducting tactical ISR targeted on Red. While an important component in MOUT, this generates only a partial understanding of the urban battlespace.

Some Proposed Activities

Pathfinder ACTD	An effort that would develop tactical robotics for MOUT.
Small-Unit Remote Scouting System	Organic reconnaissance assets for small units.
Spectre Kite	Allowing control of tactical UAVs from a variety of aircraft.
Taclink	Allow ground units to directly receive real-time Predator UAV video via small hand-held receivers.
Three-Dimensional Imaging Laser Radar	This effort will focus on airborne 3-D mapping capabilities.
Urban Intelligence Preparation of the Battlefield ACTD	An effort aimed at the operational level.
Urban and Obscured Target Detection and Identifications	This effort would work on the problem of detecting and categorizing structures, including buried ones. Included in this would be a laser mapping function.
Urban Reconnaissance Development	This effort would seek to solve the deficiencies in obtaining and disseminating useful and timely reconnaissance information in the urban environment.
Urban Target Detection and Identification Sensor System Concept	This effort would develop a range of multispectral sensors for use by aircraft. These sensors would be assisted by tagging technologies in differentiating between Blue, Red, and White.
Urban Target Detection and Identification Using Multi-Spectral and Hyperspectral Imaging (Urban MSI/HIS)	An effort to explore multi-spectral and hyperspectral imaging from airborne platforms.
UAV Operational Concepts Study	This effort would explore future concepts and joint operational employment for UAVs in MOUT.
Vanguard ACTD	This effort would be a joint Army-Marine Corps effort acting as a follow on to the MOUT ACTD.

2. Shape

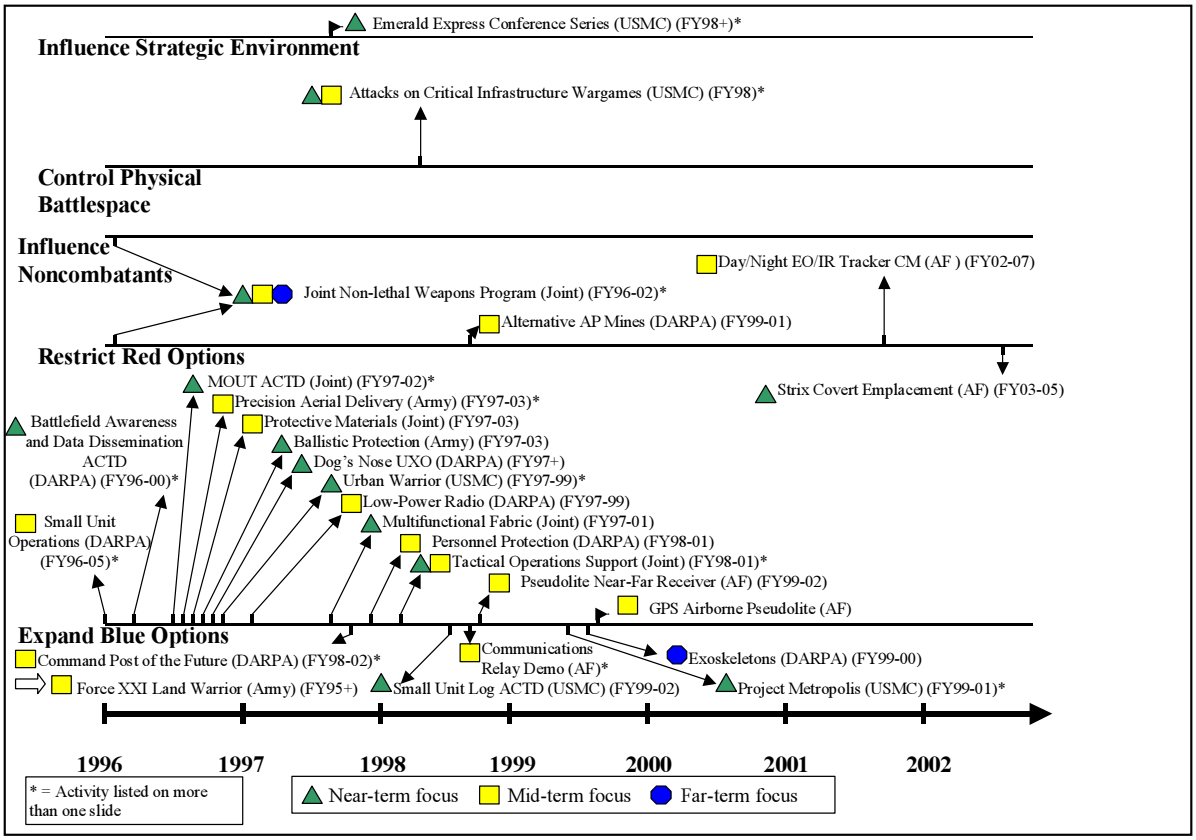

Figure IV–2. MOUT Activities: Shape

The bulk of the efforts aimed at shaping the urban battlespace is designed to expand Blue options. Many of these efforts address Blue force protection and Blue command and control. Two "Blue" areas that receive substantially less attention are enhancing urban mobility and urban logistics.

The three other possible targets of shaping are receiving little attention. Activities that look to shape Red, the civilian population, or the physical structure of the city are rare. The Joint Non-Lethal Weapons Program stands out as giving attention to shaping both Red and the civilian population. Another example is the ATTACKS ON CRITICAL INFRASTRUCTURE war game series which explored how to control the infrastructure of a city without destroying it in the process.

As with the Understand component, the activities that are focused on shaping the urban battlespace pay little attention to the operational and strategic levels. The Emerald Express Conference series was unusual in that it looked at refining coordination across a wide range of actors (e.g., Services, agencies, NGOs) likely to be present during an ur-

ban operation. A lack of that coordination would have operational and strategic implications.

Some Proposed Activities

Aircraft Susceptibility Experiment	This effort would look at the feasible of conducting rotary-wing operations during daylight hours in the urban environment.
Combat Missions IRCM (CMIRCM) Prototype System	This effort would develop countermeasures against infra-red (IR) and electro-optical sensors for stealthy and high performance aircraft.
Light-Weight Modular Support Jammer	This effort would develop light-weight and inexpensive radar-jamming equipment that could be used on a range of platforms, including UAVs, or as independent airdropped expendable devices.
Preemptive IRCM (PIRCM) Prototype System	This effort would develop technology for detecting and jamming IR and electro-optical sensors.
Spectre Kite	This effort would allow control of tactical UAVs from a variety of aircraft.
Urban Combined Arms Exercise	This effort would explore the lessons learned from PROJECT METROPOLIS.
Vanguard ACTD	This effort would be a joint Army-Marine Corps effort acting as a follow-on to the MOUT ACTD.

3. Engage

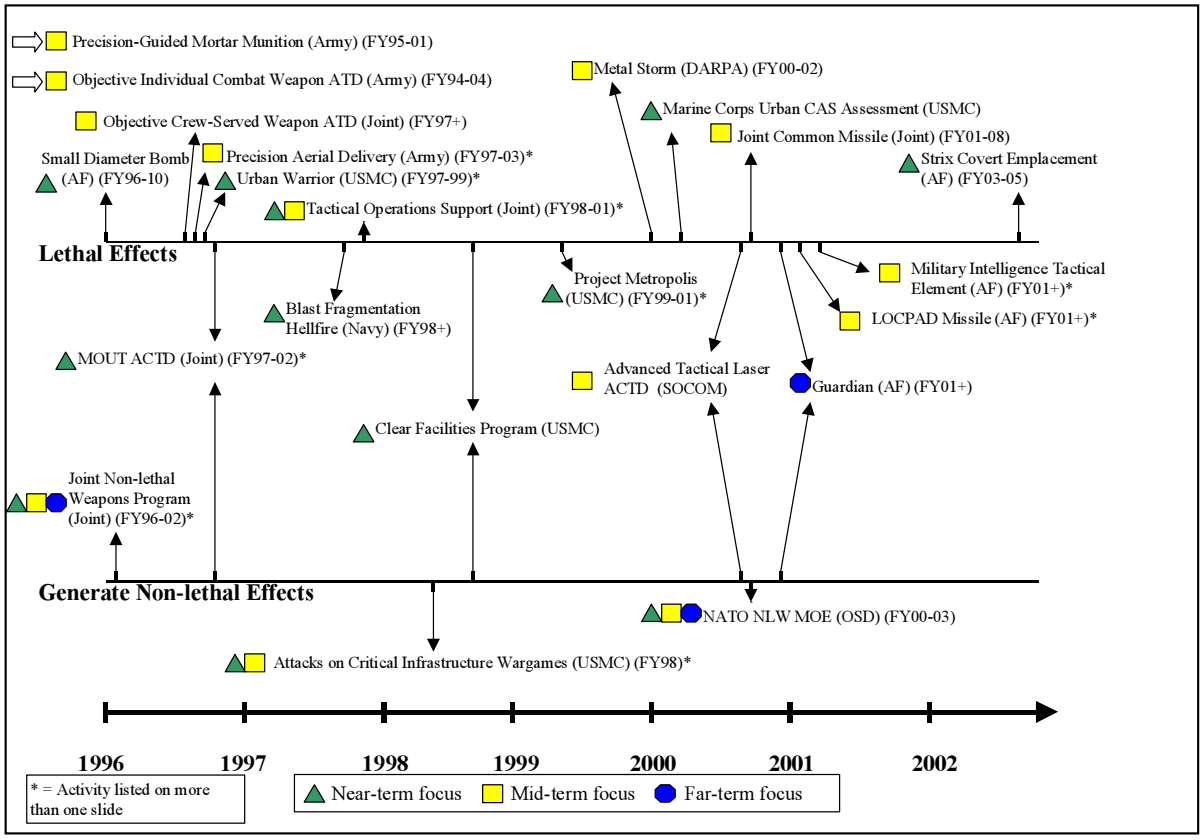

Figure IV–3. MOUT Activities: Engage

Most of the activities addressing urban engagement are looking at lethal means. The Joint Non-Lethal Weapons Program and the ATTACKS ON CRITICAL INFRASTRUCTURE war games are both unusual in their focus on non-lethal means of engagement. The MOUT ACTD effort, the Clear Facilities program, Guardian, and the Advanced Tactical Laser ACTD all stand out in covering both lethal and non-lethal engagement options.

Some Proposed Activities

Urban Combined Arms Exercise	This effort would apply lessons learned from PROJECT METROPOLIS free-play urban experimentation to the full spectrum of MAGTF (Marine Air-Ground Task Force) firepower in a live- fire environment. The goal is to ascertain effective TTP for employment of combined arms in the urban environment in support of a maneuvering Ground Combat Element.
Nevada Training Initiative: Urban Target Array	This effort would build a 640-acre (one square mile) urban training site in Nevada. This large facility would allow for aviation training that is not currently possible.
Vanguard ACTD	This effort would be a joint Army-Marine Corps effort .

4. Consolidate and Transition

Consolidate

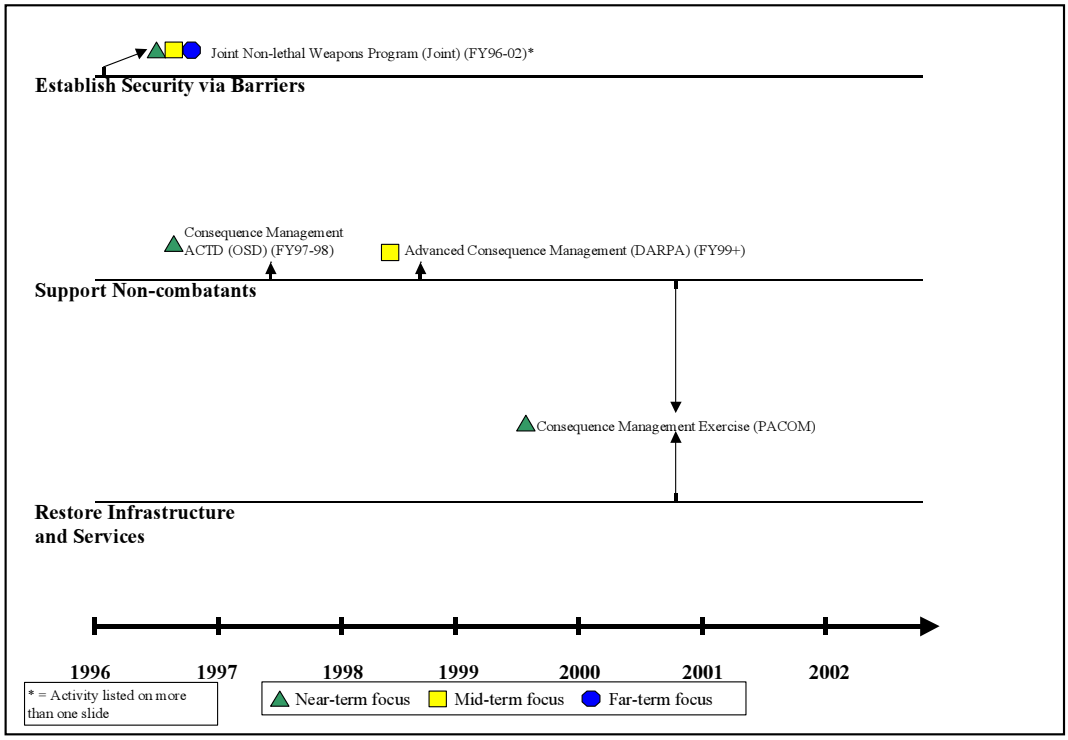

Figure IV–4. MOUT Activities: Consolidate

Across the full spectrum of DoD MOUT activities, very few efforts address the issues of how to consolidate urban areas under Blue control and how to transition those areas over to civilian control. The one aspect of Consolidate that does receive some attention is *consequence management*. As valuable a contribution as that is, a focus on only consequence management leaves other aspects of Consolidate uncovered:

- Restoring infrastructure after extensive destruction by conventional munitions will require large amounts of coordination, logistical support, and engineering expertise.
- The support of large civilian populations entails a great deal more than decontamination of urban areas.

The scale of support required for these tasks will be far beyond the organic capabilities of whatever US military force is on site. *Coordination* will therefore be the key because the resources for both restoring infrastructure and supporting the civilian population will largely come from other governmental agencies, local sources, and NGOs.

Few efforts have addressed the task of providing security to urban areas under Blue's control. Current capabilities require extensive manpower resources for security duties. The Joint Non-Lethal Weapons Program is an exception with one of its focal points being improved barrier technologies for controlling the movement of vehicles or personnel.

Transition

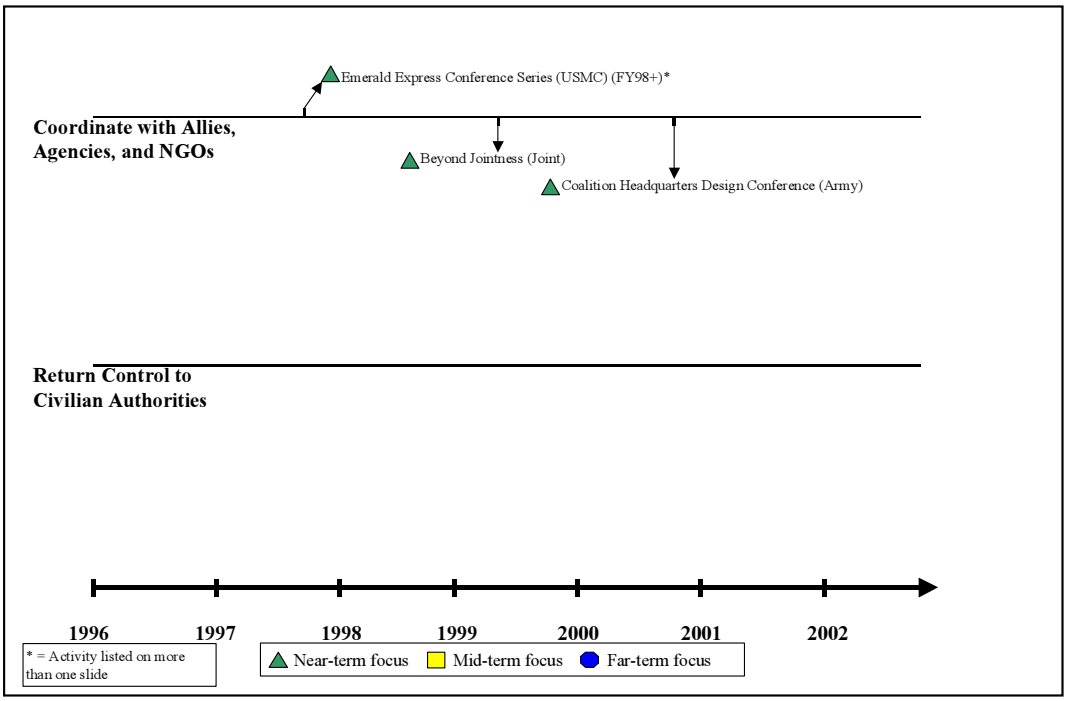

Figure IV–5. MOUT Activities: Transition

The area of Transition also is receiving little attention across the span of DoD urban activities. The Emerald Express Conference series, the Coalition Headquarters Design Conference, and the Beyond Jointness Conference all stand out as giving more consideration to this phase of MOUT by addressing coordination issues.

D. Sub-Roadmaps – Supporting Activities

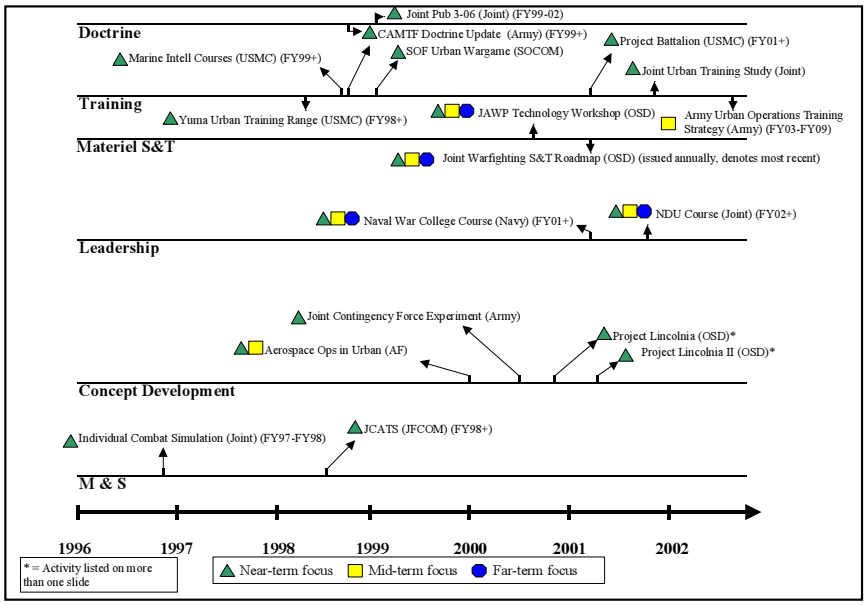

Figure IV–6. MOUT Supporting Activities (1)

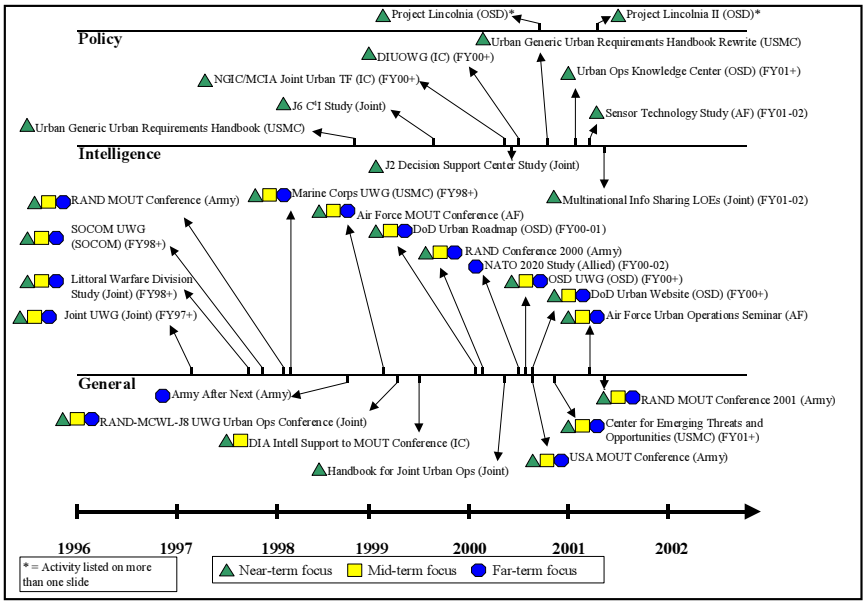

Figure IV–7. MOUT Supporting Activities (2)

Timelines for some Supporting Activities are given in Figures IV–6 and VI-7 on the previous page. A few general comments follow.

- The primary effort toward joint Doctrine development is Joint Publication 3-06.
- Several Training activities are focusing on both the issues of facilities and how to train.
- Under Materiel Development, the OSD S&T Plan has a section that describes an urban operations S&T roadmap. The desired capabilities identified in the OSD S&T Plan are compared with those identified in this Roadmap process in Volume II, Appendix B.
- Regarding Leadership development, in 2001 both the Naval War College and the National Defense University will begin to offer courses in urban operations to address leadership education.
- Several efforts are addressing concept development, some listed under Concept Development (see Figure IV-6), and some under General (see Figure IV-7).
- The area of urban Modeling and Simulation has only one ongoing entry (JCATS).
- Regarding the topic of Policy, only PROJECT LINCOLNIA and LINCOLNIA II have given major attention to the issue.
- Intelligence activities are looking at how and what to collect, dissemination and analysis, and future needs. The Defense Intelligence Urban Working Group is preparing a roadmap addressing the intelligence aspects of urban operations.
- The category of General Support (Figure IV-7) is populated by studies and conferences addressing various aspects of MOUT.

E. Summary of Overall Patterns in Ongoing MOUT Efforts

Several patterns emerge when looking at the more than one hundred MOUT-related activities cataloged by this document.

The first is the propensity to address tactical issues. While there are certainly efforts focused on solving MOUT problems at the operational level (e.g., Extending the Littoral Battlespace) and strategic level (e.g., LINCOLNIA I and II), the bulk of the efforts fo-

cus on tactical issues. Improvement of tactical capabilities would substantially benefit overall MOUT capabilities, but if a dramatic improvement of US MOUT capabilities is to be realized, then those *tactical improvements* will need to be employed within the context of *new operational concepts*. In turn, those new operational concepts will need to incorporate the *strategic aspects* of MOUT.

A second pattern is the balance between those efforts focused on the near- and mid-term versus the far term. On the first five timeline charts shown in this chapter (each representing a letter of USECT), each effort was given a symbol(s) to denote the likely time of its availability. The three categories were availability to US forces within five years (near term), five to ten years (mid-term), and beyond ten years (far term). In looking across all of the programs listed on these timelines, the efforts with a far-term focus represented only 8% of the total. The remaining 92% of the efforts focused on either the near- or mid-term. While this imbalance doesn't necessarily signify a problem, it is worth noting. Some of the more demanding problems with today's urban operations (e.g., ISR) may require breakthrough technologies. These breakthrough technologies may require long-term investments along with a tolerance for risk.

A third pattern relates to the individual components of USECT. Within each component of USECT, the activity patterns are clustered. The bulk of activities directed at Understand is focused on Red. Conversely, the civilian population is the target of only a few activities. The bulk of the Shape activities aims to expand Blue options. However, few of the Shape activities look to affect a city's infrastructure or the civilian population. The preponderance of activities addressing Engage focus on imparting lethal effects, although several programs are exploring both lethal and non-lethal effects. In the areas of Consolidation and Transition, the pattern is a general lack of activity. This is also true of issues pertaining to coordination between the military, interagency, multinational partners, and NGOs.

The fourth pattern concerns DOTMLPF. Of all the programs identified in this document, about 60% represent Materiel solutions. The remaining areas of DOTMLPF (Doctrine, Organization, Training, Leadership, Personnel, and Facilities) make up the other 40%. This apparent preference for Materiel solutions is not necessarily problematic. As long as the full span of DOTMLPF is considered in efforts to improve future MOUT capabilities, then no potential solutions will be missed.

F. Sub-Roadmaps – DoD Organizations

The above sections describe programs and activities according to either the capabilities they address (using the USECT scheme) or the type of supporting activity that can lead to needed changes (using the DOTMLPF scheme). In this section we discuss programs and activities from the perspective of various DoD organizations including the Office of the Secretary of Defense (OSD), Joint Staff, Services, Defense Intelligence Community, and Joint Non-Lethal Weapons Directorate. Appendix B contains additional de-

scriptions that focus on the specific issues of Ground Vehicles, Medical Support, and Robotics.

1. Office of the Secretary of Defense

Since July 1999, the Office of the Deputy Assistant Secretary of Defense for Requirements, Plans, and Counter-proliferation Policy (DASD RP&CP) has served as the focal point for OSD and the Secretary regarding joint urban issues.

OSD Urban Working Group. In response to the findings of the DPG-directed urban studies and analyses conducted by the Joint Staff from 1997 to 1999, RP&CP established an informal OSD Urban Working Group (OSDUWG) to serve as an urban coordination body within OSD.

Defense Intelligence Urban Working Group. Simultaneously, the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence (ASD C3I) established a formally chartered Defense Intelligence Urban Working Group (DIUWG) to address shortcomings identified in the urban ISR study conducted by the Decision Support Center (DSC) under the guidance and purview of the Joint Urban Working Group (JUWG).[1]

The DoD Urban Operations Journal. From 1999 to 2001, the OSDUWG, in collaboration with the DIUWG, other offices of OSD[2], and the Joint Staff, developed and currently maintains a DoD urban web site, The DoD Urban Operations Journal.[3] Established in FY 2001, the Journal serves as a focal point for the exchange of urban-specific information relating to ongoing world-wide urban activities as well as a place where DoD can share ideas relating to urban operations. This same collaborative effort has also resulted in PROJECT LINCOLNIA, the first attempt by the Department to address, through exploration and experimentation, strategic and operational-level imperatives in complex urban contingencies.

Other DoD Roadmaps. Other OSD initiatives include sponsorship of the DOD Urban Operations Roadmap being developed by the Joint Advance Warfighting Program (JAWP) at the Institute for Defense Analyses, and the concurrent and coordinated DIUWG effort to build the DoD Urban ISR Roadmap.

---

1 US Department of Defense, Joint Staff, Joint C4ISR Decision Support Center, *Urban ISR Study*, June 2000. SECRET/NOFORN.

2 Special Operations/Low Intensity Conflict; Program Analysis and Evaluation; Advanced Systems and Concepts; Personnel and Readiness; Net Assessment) and the Joint Staff, with funding support from Advanced Systems and Concepts. Advanced Systems and Concepts porvides funding support.

3 https://ca.DTIC.mil/urbanops/

Other OSD initiatives. In addition, and in coordination with the development of the DoD Roadmap effort, the OSDUWG has established informal working groups within DoD that are currently addressing policy implications of NLW employment in urban areas, urban Joint Professional Military Education (JPME), urban joint training and readiness, interagency coordination and collaboration, and the development of a web-based decision support and collaborative tool, the "Knowledge Center," for urban ISR. Simultaneously, each of these efforts is also being coordinated with European allies as part of a NATO Urban Roadmap effort that is scheduled to be completed in June, 2002.

Directions — OSD

Formal implementation of the Roadmap. Although ongoing activity has successfully begun to address relevant and important urban issues, more needs to be done. While both the OSDUWG and the DIUWG continue to provide a vehicle for coordination of DoD efforts related to urban operations issues, a more formalized process is needed to better coordinate and adequately fund DoD Joint Urban activity. Recommendations and options for consideration related to this issue are included in Chapter VII, Implementing the Roadmap, of this volume.

2. Joint Staff

Joint Urban Working Group. Focused at the JFC level, the CJCS J8 Dominant Maneuver Assessment Division has served as the focal point for operational-level military assessments regarding joint urban issues for the past five years. Over that period of time, the informal JUWG collaborated on, participated in, supervised, and led joint urban assessments and war games in the areas of joint urban doctrine; urban M&S; joint urban capabilities; urban ISR; urban command, control, and communications (C3); and joint urban training and facilities. War game and assessment findings from these efforts resulted in the development of a non-doctrinal publication, *Handbook for Joint Urban* Operations[4], and approval of a *Joint Urban Doctrine* publication. These assessments also identified shortcomings and gaps regarding current, joint, operational-level urban capabilities, and served as the starting point for the development of this Roadmap.

Special Study Group for Joint Urban Operations. Recently, the informal J8 JUWG transitioned to the formally chartered Joint Urban Operations Working Group (JUOWG). The JUOWG was tasked to support the newly established flag-level Special Study Group (SSG) for Joint Urban Operations (JUO). The JUO SSG was established on 21 January 2001 by the Joint Requirements Oversight Council (JROC) to serve as an interim focal point for joint urban issues. This was in response to, and acknowledgement

---

4 See the bibliography in this volume.

of, the results of the JUWG assessments and the Joint Mission Area Analysis/Joint Mission Need Analysis (JMAA/JMNA) conducted by the Dominant Maneuver Joint Warfighting Capabilities Assessment Team.

The JUO SSG also supports the JROC Chairman in the strategic management and integration of combatant command, Service, and Joint Staff efforts. These efforts include identifying joint requirements and developing appropriate materiel and non-materiel solutions to address mission needs in order to improve US capabilities to conduct joint urban operations. The JUO SSG will function until 31 December 2002 unless its charter is extended or terminated in writing by the JROC prior to that date.

The JUO SSG has representation from the Joint Staff, the Services, Joint Forces Command, Special Operations Command, and DIA. It is in the process of identifying a permanent focal point and lead for joint urban operations issues. The JUO SSG is also overseeing the development of the *DoD Urban Operations Master Plan*, a detailed plan to address the directions identified in this Roadmap.

Directions – Joint Staff

Previous and ongoing activities have identified further actions that remain to be done by the Joint Staff.

- Establish and recommend to the Secretary of Defense an Executive Agent for joint urban operations.
- Assess areas such as close air support, rotary wing aircraft, combined arms, interoperability, medical support, logistics, and interagency and multinational aspects of urban operations in order to identify joint shortcomings and recommend solutions.
- Expand and develop war games, seminars, joint experiments, and exercises in order to address joint, interagency, and allied issues and capabilities.
- Expand and develop robust concept development and joint experimentation for joint urban operations in order that DOTMLPF implications can be identified and addressed.
- Starting from the findings and insights of the Roadmap, the SSG, in consultation and cooperation with OSD, should develop a detailed *DoD Urban Operations Master Plan* to address the issues identified in this Roadmap and other issues yet to be identified.

3. US Army

Throughout its history, the US Army has conducted operations in villages, towns, and large cities both here and abroad. Urban areas such as Trenton, Mexico City, Fredericksburg (Virginia), Aachen (Germany), Seoul, Santo Domingo, Saigon, Panama City, and Mogadishu are but a few examples. Recently, the Army deployed forces to Bosnia and Kosovo to conduct peacekeeping and peace enforcement operations as well as humanitarian missions in the cities and towns there.

In October 1996, the Defense Science Board concluded that urban areas would be the likely battlefield of the future, and that the armed forces should assess their capabilities to conduct urban operations.[5] The world is becoming more urbanized, and it is clear, based on current deployments and missions, that the Army will continue to conduct urban operations.

Since the end of the Cold War, the Army has been transitioning from a force focused on a threat to a force focused on capabilities. The Army is focusing its capabilities on conducting full spectrum operations (offense, defense, stability, and support) in more complex environments. Potential enemies are likely to use urban areas in an attempt to marginalize the Army's strengths. Enemies are also likely to change from conventional operations, when threatened by US intervention, to pursuing an asymmetric strategy that would include Information Operations to win media support and sway public opinion against US involvement.

Combined Arms MOUT Task Force Study. The Chief of Staff of the Army directed the Training and Doctrine Command (TRADOC) to conduct a study on urban operations to facilitate the Army's urban effort. TRADOC designated the US Army Infantry School (USAIS), which is the Army's designated proponent for urban operations warfare, to lead this effort. In January 1999, the Commandant of USAIS established a Combined Arms MOUT Task Force (CAMTF) to conduct this study and designated the Deputy Commandant of USAIS as the Director of the Task Force.

The study, an 18-month review, analysis, and assessment of urban operations readiness across the Army, was a coordinated product, reflecting the advice of all Major Army Commands (MACOMS). During the study, the CAMTF conducted detailed Missions Needs Analysis (MNA) assessments under D-T-L-O-M-S[6] components, seeking possible non-materiel solution sets (D-O-T-L-S) to urban operations readiness training for full spectrum operations. The study pointed out that both the Commander in Chief's Integrated Priority Lists and their Army Service Component Commanders/MACOM

---

5 U.S. Department of Defense, Defense Science Board, *1996 Summer Study Task Force on Tactics and Technology for 21st Century Military Superiority*, October 1996.

6 Doctrine, Organization, Training, Leadership, Materiel, Soldiers.

Unit Status Reports identified the lack of urban operations training facilities as an area to focus on to improve their ability to accomplish their specified Theater missions and tasks under the National Military Strategy, DPG, and the Joint Services Capabilities Plan.

New and revised field manuals. The Combined Arms Center at Ft. Leavenworth, Kansas, in cooperation with the CAMTF, continued the process of updating FM 90-10 as a new FM 3-06, *Urban Operations*, (Initial Draft), dated 15 November 2000. This was performed in direct support of joint warfare and joint doctrine JP 3-06, *Joint Urban Operations* (Draft). Concurrently, the Combined Arms Center rewrote FM 3-0, Operations.

Mission Essential Tasks List. Also, the Army identified multiple tasks related to fighting in the urban environment within the Army Universal Task List that yield the Mission Essential Tasks List (METL) upon which army units must provide a monthly Unit Status Report (USR) on their combat readiness, under the standards defined in AR 220-1. This highlights the need for the Army to continue to develop the ability to execute these tasks in urban environments.

Joint MOUT ACTD. As part of the overall Army urban effort, the Army invested additional resources in MOUT experimentation, facilities, and other intellectual endeavors addressing the transformation of the Army. The most robust experimentation was conducted under the Army–Marine Joint MOUT ACTD (see Appendix A in this volume), which addressed small-unit tactical urban combat. Recently completed, this ACTD provided:

- leave-behind, commercial- and government-off-the-shelf, near-term tactical equipment;
- impetus for the ongoing CAMTF effort to update urban TTP and doctrine Army wide; and
- the development of a construction plan to build new urban training facilities.

Directions — Army

Future Army efforts. Although the CAMTF and MOUT ACTD efforts highlight the progression of tactical urban issues, the Army is striving for greater gains. Doctrine development will continue to emphasize and refine urban operations; however, this will not be an end in itself. Among the efforts that will be pursued:

- The Army will seek support for its effort to develop the Corps-and-below field manuals, training support packages, and mission training plans since doctrine alone is insufficient to ensure force readiness for urban operations.

- The Army will seek to continue to improve the performance-oriented training methodologies that replicate conditions comparable to actual urban conditions.

- The Army will continue to improve the development of battalion- and brigade-sized urban training facilities as well as emphasizing the combined arms, joint, and multinational aspects of training.

- Another challenge is that the current simulations and simulators need further development in order to (1) support the Army's needs for training soldiers, leaders, and units at the tactical level, and (2) address the issues related to combined arms, interoperability, joint, and multinational operations.

At times the use of real urban locations for training may be impractical and infeasible, so the Army will need training capabilities that capitalize on digital means such as distance learning and knowledge-reach-back technologies. Simply put, a challenge for the twenty-first century is to be able to augment the teaching of urban operations in the schoolhouse with digital simulations that enhance exposure to new urban TTP.

Live training facilities. To facilitate the improvement in training and to provide a focus of effort, the CAMTF identified four types of live training facilities required for Active and Reserve forces to train to doctrinal standards:

- live-fire shoot houses for individual through platoon live-fire exercises (LFXs);

- LFX Urban Assault Courses to improve small unit teamwork in the complex urban battlespace;

- tailored breach facilities for individual, squad, and platoon proficiency in urban breaching operations (designated METL tasks to standards); and

- Combined Arms Collective Training Facilities (CACTF) at home stations and Collective Training Facilities (CTF) at the Maneuver Combat Training Centers to enable combat readiness training at the Combined Arms Brigades, Battalions, and Companies.

All of these fully instrumented training facilities would provide capstone collective training that would support doctrinally correct training events (with instrumented feedback) to assess the extent of full combat readiness at the battalion and brigade levels.

Live, virtual, and constructive training. Furthermore, to fully develop leaders, units, and individuals, training must contain the right blend of live, virtual, and constructive training. Currently the available constructive and virtual simulators are insufficient to support the needs of the Army, and future simulations and simulators for urban operations will

require a greater level of funding by the Department. The Army is actively engaged in seeking support for the development of a seamless, live-virtual-constructive training environment for urban operations with relevant software, databases, and live-virtual linkages.

D-T-L-O-M-S. War games, seminars, experiments, and exercises can address urban challenges regarding concept development and experimentation above the tactical level in areas such as logistics, medical, armor, rotary wing, and combined arms. The Army is actively seeking support for the development of concepts for urban operations and experiments that will facilitate the transformation to the objective force. While the Army has doctrinal and training literature to support urban operations training, it is constantly seeking new urban strategies across the domains of doctrine, training, leader, organizations, materiel, and soldiers (D-T-L-O-M-S). Current challenges include maintaining and resourcing doctrine, training literature, and facilities. The Army has processes in place that identify the requirements; however, the key to success is providing Army leaders with the D-O-T-L-M-S that will ensure success in conducting urban operations in the twenty-first century.

Army Master Plan. The Army is currently building upon the foundation of the CAMTF and has initiated an analysis (at the Combined Arms Center, Fort Leavenworth, KS) of the DoD charter for urban operations to provide input into the process of developing a Master Plan. Provided the appropriate and necessary resources to fully develop a Master Plan are made available, the Army is committed to the joint effort to ensure the United States is capable of meeting the urban challenges of the twenty-first century.

4. US Navy

One would think that a blue-water Navy has little need to address challenges associated with urban environments, but over the past decade, littoral areas—those areas within 200 miles of the sea—have become central to naval strategy. For example, most major airfields and port facilities capable of supporting sustained large-scale military operations are located in urban areas within these littorals. Whether in support of land operations ashore, conducting strikes, maintaining presence, or other roles, naval forces will have to confront the challenges of the urban environment in most twenty-first century scenarios. Sea-based aircraft, sensors, weapons, munitions, and communications will have to be effective in urban environments.

In response to the increasing importance of urban environments to littoral operations, a course in urban operations addressing some of the strategic issues associated with that environment has been introduced into the formal curriculum at the Naval War College during the 2001–02 academic year. However, urban requirements have not played a significant role in most Navy development programs. For example, the Extend the Littoral Battlespace (ELB) ACTD has made progress regarding naval C2 network and architecture issues for littoral operations, but it has not directly addressed challenges associated

with urban areas. The same may be said of other areas such as aviation munitions, naval surface fire support, and ISR.

Directions — Navy

Improvements that adapt traditional naval force capabilities to urban applications are needed. Examples include sea-based or sea-launched, urban-capable C4ISR systems, including UAV- and UCAV-type systems; munitions that are capable of generating lethal or non-lethal precision effects in an urban environment; sea-based, urban-capable, survivable platforms for mobility; sea-based precision logistics systems; and sea-based medical capabilities. The inherent availability, flexibility, and adaptability of naval capabilities for strike, fire support, standoff logistics, air defense, C4ISR, etc., would enable naval forces to meet crucial needs in urban settings. However, without a concentrated effort to adapt current capabilities for urban applications, its relevance and usefulness in such operations will remain limited.

5. US Air Force

A number of myths currently exist regarding urban operations. One is a belief that the US Air Force has little or no role—and limited capabilities—during urban operations. Nothing could be further from the truth. This premise is not supported by historical evidence, and when considering the unique capabilities that air and space power provides to any contingency (e.g., C3, ISR, precision strike, logistics support), it is clear that such capabilities will be critical to successful JTF urban operations in the future.

As in the past, air and space capabilities will likely prove integral to any concept that offers an effective military strategy while also minimizing risk in an urban environment. Air and space power can provide leverage in many aspects of a joint force urban operation. For example:

- in the context of achieving direct, precision effects against key adversary nodes;
- decisively enabling high-tempo, parallel, joint force operations; or
- providing real-time, three-dimensional, actionable intelligence, surveillance, and reconnaissance to the Joint Force Commander.

Failure to bring to bear the advantages of joint air and space capabilities in the urban environment puts operational success seriously at risk. A full complement of joint military power to include air and space capability in all its forms is the key to achieving national objectives in this most challenging of all operational environments.

While air and space power alone cannot meet all needs within an urban context, many of the capability shortcomings identified in the components of USECT lend themselves to air and space solutions. There is reason to be optimistic that dramatic improvements could be achieved in joint force capabilities to operate in urban areas if these capabilities are improved upon and synchronized with ground, naval, intelligence, and national assets.

Over the past few years, the Air Force has labored to increase Service awareness of the challenges that the nation will likely face in future urban operations from major theater war scenarios to operations other than war. These efforts have included two urban operations conferences, articles in military journals, and the release of a RAND study, *Aerospace Operations in Urban Environments: Exploring New Concepts* (see the bibliography in this volume). More recently, several efforts have addressed these challenges, among them:

- **Urban Target Array.** To address shortcomings in urban training requirements, the Air Force is developing the URBAN TARGET ARRAY at the Nevada Test and Training Range. The project's objective is to improve, through realistic training, the joint core mission capabilities of B-2, B-1, B-52, F-22, F-15, F-16, F-14, F-117, F-18, AC-130, A-10, and AV-8 aircrews to accomplish Interdiction and Close Air Support (CAS) missions in urban terrain. It will also support the training of UAV operators to find and identify ground threats in an urban environment as well as support training for space and information operations personnel tasked to perform their operations in urban environments.

- **Small Diameter Bomb.** Related to the URBAN TARGET ARRAY project, an effort by the Air Armament Center at Eglin AFB, Florida, is developing the Small Diameter Bomb (SDB). The SDB is a precision-guided weapon system (150- to 250-pounds) that enables engagement of high-value hard and soft targets in an urban environment with minimal collateral damage. The SDB will leverage technology advances (e.g., GPS-aided INS (Inertial Navigation System) guidance, seeker, fuze, warhead, and control surfaces) from other precision-guided weapon programs (e.g., JASSM, JDAM, JSOW) to deliver relatively small unitary warheads against fixed, re-locatable, and mobile targets. To support further urban weapons development, the Air Force Research Laboratory has established an urban/CAS Integrated Product Team to explore and develop the next generation technologies that support future joint urban operations.

- **Sensor technology.** Recognizing the need to improve targeting in urban areas, the Air Force Scientific Advisory Board gave priority focus to the urban environment in its 2001 Summer Study on Sensor Technology for Difficult Targets. Several members of the study made up the "urban panel," whose

mission was to identify sensors with the highest payoff in urban environments.

See Appendix A for additional descriptions of these efforts.

Directions – Air Force

While several initiatives are focusing on improving current Air Force capabilities to operate in the urban battlespace, much more needs to be done. Some examples follow.

Outstanding urban terrain challenges. Although significant resources have been invested in improving USAF intelligence capabilities in open terrain, current surveillance and reconnaissance platforms have significant shortcomings when tasked to perform in built-up areas. While some technologies are available which might help with this shortcoming, much more needs to be done to address challenges that are characteristic of urban terrain such as limited lines of sight, infrastructure, activity patterns, and the presence of civilians.

Better use of UAVs. Continued improvements in the capabilities of UAVs in open environments can be expected as the programs mature over time. However, the use of UAVs in an urban environment presents special challenges with regard to such aspects as navigation, C3, networking, and IFFN (the identification of friend, foe, and/or neutral). Additional developmental work on concepts of operations and enabling technologies are required to realize the full potential of UAVs in urban areas.

Smart munitions. Although current programs are addressing the warheads of smart munitions, more research is needed regarding the special needs of the urban environment. For example, overpressure issues are especially critical in confined areas, and a 15 to 30-pound warhead may often be too much. Also, warheads should not always be fragmentary but may have to be shaped for penetration or cellulose for emphasizing overpressure to break out windows.

The need for jointness. Whatever the possibilities for air and space contributions to urban operations, the lack of joint training and experimentation inhibits improvements and is currently a major deficiency. Although the current development of joint doctrine will help guide future efforts in this area, a more concerted effort is required for the development of joint operational concepts and the conduct of realistic joint training and experimentation at the tactical and operational levels of war. In this vein, there is a conflict regarding the need for responsive "I need it now" support and the adaptability and timeliness of the Air Tasking Order (ATO). The current 72-hour planning cycle is not well suited to the complexities of the ever-changing situation within an urban area, and modifications and work-arounds will be needed. Solutions may involve stacking air and/or placing aircraft on strip alert. But whatever the solutions, a joint venture is required.

Airspace deconfliction. A related challenge is that of airspace deconfliction in urban areas. Long-range missiles, rockets, small UAVs, helicopters, and fixed-wing assets do not have wide berth in urban air space, and little has been done to address this issue.

Reorganization and integration. Addressing air and space roles in urban operations will require visibility throughout the Air Force, and doing that may require some organizational changes. Headquarters Air Force is beginning to address this issue by taking on the responsibilities associated with the Joint Urban Operations Working Group and by placing a flag officer on the Special Study Group for Joint Urban Operations. Additionally, discussions have begun and a proposal is being made that the Air Staff develop firmer links between the battle labs, the R&D communities, Air Combat Command, Air Force Special Operations Command, and Air Force Material Command. If adopted, this will allow for an integrated approach to the development of urban-related requirements, concepts, and weapons, as well as urban training and experimentation.

6. US Marine Corps

The Three Block War. The Marine Corps, arguably the most active service regarding efforts to improve near-term urban capabilities over the past five years, has invested significant intellectual and experimental resources in this area. The previous Commandant of the Marine Corps, General Charles Krulak, championed the call for improved urban capabilities and led the debate within DoD. His "Three Block War" analogy[7] has become a widely-used expression that captures the complexities of urban operations, and the need for improved capabilities.

Experimentation. Although focused at the tactical level, Marine Corps experimentation, seminars, and war games have addressed a wide range of urban battlespace functions. War game findings have focused on communications, fire support, non-lethal effects, coalition operations, infrastructure attack, and difficulties associated with NGO coordination. These war games have provided a basis for the development of Limited Objective Experiments and Limited Technical Analyses as well as fully manned exercises involving both Active and Reserve components.

The largest of these exercises, URBAN WARRIOR, was conducted in 1998 in the San Francisco–Oakland area and involved an embarked Marine Expeditionary Unit (MEU) tasked to conduct a "Three Block War" scenario against a Reserve Marine Infantry Battalion serving as the OPFOR and in the presence of civilian role players. Data gleaned from this event led to a follow-on 2000–2001 experiment, PROJECT METROPOLIS (PROMET), conducted in the housing unit of George Air Force Base in California, which

---

[7] In modern-day urban operations, US forces may be required to conduct humanitarian assistance, peacekeeping, and intense combat simultaneously (or in rapid succession) and in close proximity (in neighboring blocks).

had been closed during the rounds of Base Realignment and Closure (BRAC). PROMET focused on the improvement of urban TTP for infantry small units and mechanized and armored assets, and addressed urban specific applications of airpower.

Urban Close Air Support. An Urban Close Air Support (UCAS) Assessment was completed in FY 2000, which examined CAS for both fixed-wing and rotary-wing platforms. Timeliness, accuracy, and survivability were the measures of effectiveness used to gather data, and Marine Aviation Weapons Training Squadron-1 (MAWTS-1) recently published the results. This data is being further refined at the Urban Live-Fire CAS range in Arizona. Extensive efforts have also been initiated at the Marine Corps Warfighting Laboratory (MCWL) to specifically determine the effectiveness of the Marine Corps' rotary-wing aircraft in an urban environment. The first experiment was completed in Feb 2001 and will be followed in FY 2002 by a Limited Technical Analysis (LTA) at George AFB and at Marine Corps Air Station (MCAS), Yuma, AZ. The LTA will focus on the effectiveness of rotary-wing CAS and assault support. Survivability and combat identification will also be examined.

Joint doctrine publication. The Marine Corps has been assigned as the DoD Executive Lead Agent for drafting joint doctrine for urban operations. Joint Publication 3-06, *Doctrine for Joint Urban Operations*, 2002.

Small Wars Manual updates. Also a second volume of the classic *Small Wars Manual*, which will include lessons learned since its original publication in 1935, is being prepared by the Center for Emerging Threats and Opportunities (CETO). CETO is a recently established division of the MCWL, which is tasked to identify emerging non-traditional threats, explore new concepts, and determine capabilities and solutions to meet future challenges. The CETO effort, in coordination with USMC operating forces, will recommend approaches consistent with emerging capabilities to the Commanding General of MCWL for transition into the Combat Development System. In addition to other ongoing efforts, CETO is coordinating DoD's PROJECT LINCOLNIA experimentation program, which is examining urban operations at the operational and strategic levels of war.

Directions – Marine Corps

Logistics and re-supply. Wargames, seminars, experiments and exercise findings have led to progress in many areas, but they have also highlighted challenges requiring more in-depth effort to resolve. One such challenge is *logistics*, particularly in the areas of the evacuation of casualties, and *re-supply*. Regarding the first of these, grave concerns exist regarding the impact of rubble and the stability of damaged structures as they relate to finding, assisting, recovering, and evacuating casualties. Recent terrorist attacks and previous experiences, for example, of the 22nd MEU in support of earthquake disaster relief efforts in Turkey, have served to reinforce and highlight this issue. Previous USMC

efforts to coordinate with the New York City Fire Department and other non-military organizations should be expanded to help identify solutions.

Refining combined arms applications. Another area requiring more in-depth focus is that of combined arms. In the past, the application of combined arms meant the simultaneous or sequential application of both direct and indirect fires. But today the application of this open warfare concept to the restricted terrain of cities is generally inappropriate. Attacking a city with combined arms reminiscent of Stalingrad, Hue City, or Grozny represents a strategy not likely to be adopted by Western forces except in the most dire of circumstances. Yet the application of selective and more discriminate combined arms is indeed necessary, and there is high potential for improvement. Doing so, however, will require focusing more on areas such as the lethality and survivability of armor and aircraft (both fixed wing and rotary wing), as well as the introduction of sensors, GPS, and weaponry, for use in closed terrain. Also technological advancements in robotics, UAVs, and NLW hold promise and should be the subject of vigorous experimentation to identify roles for use in urban areas.

Joint experimentation. Although the two land Services have conducted joint urban activities and experimentation (the Army–Marine MOUT ACTD is an example), significant work is yet to done to address the lack of joint training, joint concept development, and joint experimentation. To fully realize the synergistic effects of the joint force, and identify needed joint capabilities, efforts must be expanded from the land force tactical efforts of the 1990s to operational-level experimentation with all-Service representation. Otherwise, incremental improvements at the tactical level may be the best we can hope for.

G. Intelligence Support to Urban Operations

The road forward that eventually leads to timely and accurate intelligence support to US forces conducting urban operations is a long one rife with obstacles and detours. Arguably, one could say that urban intelligence is currently a disparate maze of multiple roads, all under some state of construction or abandoned—construction without a defined final destination or abandoned due to resource and/or vision shortfalls.

Timely and accurate intelligence is especially critical to urban operations, more so than in other environments. Urban areas complicate military operations in ways that other environments do not. The three-dimensional, man-made topography and the presence of large noncombatant populations in urban areas present unique challenges. The influence of the complex social, cultural, and political systems, which guide the daily lives of urban inhabitants, compounds the physical difficulties associated with urban operations.

Operating in this complex "system of systems" of man-made and human terrain is even further complicated when considering that urban adversaries will use an asymmetric approach to circumvent or undermine US strengths. Specifically, urban foes will target US

vulnerabilities and make every effort to blend into the backdrop of this "system of systems" to deny and deceive regarding their disposition and intentions.

1. What Is Urban Intelligence?

Urban intelligence includes all ISR efforts that support two primary functions: battlefield visualization and situational awareness.

Battlefield visualization is the dynamic three-dimensional display and analysis of the urban terrain, features, cultural factors, forces (enemy, friendly, and uncommitted), and events in sufficient detail to support operational- and tactical-level operations. To be successful in battlefield visualization, data from national, theater, organic and non-organic collection assets, human intelligence, and operational forces must be analyzed and fused into a common picture. This picture must be constantly refreshed with new information and intelligence. However, unless an accurate and user-friendly baseline database (prepared well in advance) exists, this effort at battlefield visualization will be "playing catch-up" in this era of short notice and rapid military deployments into urban areas.

Situational awareness is the understanding of the urban battlefield in sufficient detail to support effective decision-making at all levels of command, from the squad leader "on the street" to Joint Task Force (JTF) or Theater commander. This situational awareness includes a wide range of factors, including the urban physical infrastructure; threat order of battle (OB) TTP as well as the enemy's potential and likely courses of action; and urban social infrastructure, to include the local population, culture, politics, religion, and economics. It must also include analysis on the social interaction between societal groups, the physical infrastructure, and threat and intervention forces.

2. The State of Urban Intelligence

The following are examples of findings and recommendations from past studies addressing the needs and status of urban intelligence. They also provide an overview of some key issues.

The 1994 Defense Science Board Task Force Summer Study on Military Operations in Built-Up Areas:

- Urban operations will continue to be a major area of concern for US forces.
- DoD must take a systematic approach to improving urban warfighting capabilities and designate leadership for this task.

- This approach should include examining new technologies to rapidly fill important urban requirements and establish joint doctrine, training, experimentation, urban intelligence databases, and analysis centers.

The 1998 J-8 Assessment on US Military Capabilities for Joint Military Operations on Urbanized Terrain (MOUT):

- A requirement for an urban operations analysis center.
- The existence of such a center is tied to the successful conduct of urban operations.
- One of most critical urban mission needs is a detailed, accurate knowledge of a city. The J-8 definition of this critical requirement is the ability to provide the commander detailed and accurate information of the city, to include surface and subsurface infrastructure; transportation networks; telecommunication networks; power generation and transmission grids; and economic, social, cultural and religious centers.

The 1999 Defense Intelligence Agency's Intelligence Support to Urban Operations Conference After-Action Report:

- There must be a concerted unity of effort in the IC [Intelligence Community] regarding collection and production of urban intelligence.
- There is a duplication of effort among all agencies' urban products—advice is to "link arms now."
- To correct this coordination deficiency, several participants recommended the creation of an IC Urban Working Group (UWG) to define "lanes in the road," exchange data, and create product standards.
- Participants also expressed a desire for a single comprehensive urban intelligence product.

The 2000 General Accounting Office (GAO) Report to Congressional Committees: Military Capabilities – Focused Attention Needed to Prepare US Forces for Combat in Urban Areas:

- US Forces do not have adequate information, that is, intelligence to plan and conduct urban operations, due to the lower priority the IC has afforded urban warfare in its collection efforts.
- Shortfalls in urban intelligence, including detailed information on city transportation, communications, utilities, and other facilities, are especially significant for developing countries where the potential for US urban

operations appears greatest. The absence of good intelligence for urban settings can impede operations and leave forces vulnerable to ambushes, friendly fire incidents, and unacceptable levels of noncombatant casualties and collateral damage.

The Department of Defense Response to the GAO Report:

- Concurred with the GAO report and that there was consensus across the Department that significant information and intelligence shortfalls exist for foreign urban operations.

The June 2000 J-2/Decision Support Center (DSC) Urban Intelligence, Surveillance and Reconnaissance Study:

- This study was conducted at the Secret classification level.
- At the unclassified level, this study found significant shortfalls in DoD's capability to provide quality urban intelligence. These shortfalls include urban intelligence/information collection, processing, analysis, and dissemination. The study also outlined possible solutions to address these shortfalls.

The Draft 2001 OSD C3I Defense Intelligence Urban Operations Working Group Study and Roadmap:

- While isolated pockets of "urban intelligence excellence" exist, there is no overarching strategy to aid in reducing duplication of effort, facilitating collaboration, and identifying and addressing shortfalls and gaps.
- The lack of an overarching urban intelligence executive agent and "champion" is the predominant factor that has contributed to the majority of the shortfalls mentioned here and in previous studies.
- A need for the "operationalization" of intelligence (increased operations/intelligence integration) exists. Increasingly, because of the unique requirements associated with urban analysis and intelligence-related production, as well as the compressed time line between requirement identification and deadline for delivery, operational organizations are performing these tasks "in-house." Integration is essential to ensure timely and accurate collection, production, and delivery of relevant intelligence to support the operator's needs.
- Data on, and analysis of, asymmetric urban threats to support operational and tactical operations is unavailable.

- Operationally relevant cultural intelligence data and analysis is severely lacking.
- While data on the exterior component of the urban physical infrastructure is generally good, there is a lack of data on subterranean facilities, passageways, and utility conduits.
- While the importance of Human Intelligence (HUMINT) drastically increases in the conduct of urban operations, there are insufficient resources or alternatives to meet the increase in demand traditionally collected by human sources.
- Urban intelligence shortfalls are especially significant for developing countries and for the cultural aspects of operating in restrictive terrain with a large non-combatant presence.
- Threat intelligence data and finished products are lacking for the most likely urban foe—forces using asymmetric tactics, techniques and procedures.
- Human Intelligence (HUMINT) assumes a much greater role in urban environments. There are insufficient HUMINT resources within DoD to meet the increase in requirements.
- Intelligence databases do not adequately support urban operations; this is especially true for urban areas in developing countries.
- Development of technologies and programs that enable analysis, multiple database access and fusion, and automated visualization are proceeding; it is the human element critical to analysis and database fill that is critically short.
- Though this technology and program development is proceeding, there is a lack of community-wide standards and collaboration to aid in connectivity and unity of effort.

3. Building the Road Ahead — Laying the Groundwork

Though a virtual "laundry list" of recommendations to improve intelligence support to urban operations can be constructed, unless certain key institutional changes are made, the road ahead will remain littered with good intentions and marked by unnecessary detours and unfinished lanes.

The first order of business is to implement a leadership-driven approach that builds on exposing senior DoD intelligence leaders to the need for improved intelligence capabilities, possible solutions to the problems identified in the Roadmap, and to the ways that

implementing these would improve our nation's capability to conduct successful urban operations. Without leadership's enthusiastic commitment and personal attention, all other efforts at building a road to urban intelligence excellence will fall woefully short. *Implementation of solutions will not happen unless directed and supported from the highest levels.*

Responsibility for the leadership education should lay with the OSD C3I in its role as the current DoD focal point for urban operations intelligence. It is also recommended that the group take on the role as urban intelligence "policy entrepreneurs" who recommend policies and advocate particular solutions to the problems that exist in providing timely, accurate, and relevant urban-related intelligence.

In this capacity it is recommended that the Chairman of the Defense Intelligence Urban Operations Working Group (DIUOWG) be designated as the official Defense Intelligence representative to the OSD Urban Operations Working Group and be granted observer status at the Joint Urban Operations Working Group.

It is recommended that the DIUOWG continue its work at the working level and strongly encourage participation by all operators and intelligence personnel working urban operations issues. Active participation by members of the OSD and Joint Urban Operations Working Groups ensures operators' requirements are understood and addressed by Defense Intelligence as well as keeping Defense Intelligence abreast of urban operational concepts under development. Of particular note it is recommended that the DIUOWG stay particularly engaged with organizations such as the Joint Warfare Analysis Center, the US Army Topographic Center, and the newly formed Center for Emerging Threats and Opportunities.

It is also recommended that the DIUOWG identify a cadre of urban intelligence subject matter experts to participate in urban operations wargames, experiments, seminars, and conferences. In the conduct of research for this Roadmap, the DIUOWG has identified the need for increased participation by Defense Intelligence threat and ISR subject matter experts, as it has been noted that a lack of such expertise has fostered high, and sometimes unrealistic, expectations by operators in the current and future capabilities of Defense Intelligence to support urban operations.

Implementation of the above recommendations should lead to the designation of an Executive Agent for Urban Intelligence with a mandate to conduct a thorough review of the DoD urban intelligence efforts in order to identify specific shortfalls in supporting urban operations and to formulate a master plan to address these shortfalls.

4. Urban Intelligence — Top Five Issues

In short, the top five areas posing key challenges to urban intelligence are summarized as follows:

- Cultural Intelligence
- Focus of human intelligence (HUMINT)
- Imagery Mapping Base - 1 meter unclassified
- Operations/Intelligence Integration/Interface
- Urban Intelligence Preparation of the Battlefield Defined and "Templated"

H. Joint Non-Lethal Weapons Program

The Joint Non-Lethal Weapons Program was established to provide warfighters with a family of NLW systems and a wide range of non-lethal capabilities across the full spectrum of threats and crises for the twenty-first century. The primary task of the US armed forces will continue to be to deter conflict, but should deterrence fail, to fight and win this nation's wars. As the force stands ready to fight and win with lethal force, it is certain that the Services will continue to be called upon to execute a wide range of contingency operations, including humanitarian assistance, peacekeeping, and high-intensity conflict. NLW systems can provide the JFC with a number of new options that could be employed in such contingencies.

The Joint Vision 2020 tenet of "Full Spectrum Dominance" is defined as the ability to conduct decisive operations across the full range of military operations. Such dominance of the urban battlespace will be difficult to achieve without the availability and employment of NLW. The advent of NLW systems will enhance the warfighter's ability to conduct Precision Engagement; provide a broader range of desired, precisely directed effects on targets; and significantly reduce personal injury and materiel damage. Even contingency operations associated with peacetime engagement, deterrence, and conflict prevention will continue to require the capabilities of Dominant Maneuver and Full-Dimensional Protection for rapidly and effectively controlling unruly populace or belligerent forces, and for keeping potentially explosive situations from escalating in urban environments.

1. Transformation and Uncertain Future

The most critical part of the National Security Strategy (NSS) is to prepare for uncertain futures, not just for one kind of war where precision, speed, and lethality are at the forefront, but futures where objectives can be met or achieved by means other than le-

thal. The future of NLW in support of Effect-Based Operations is currently being examined. The protection of United States and friendly forces must be foremost in our Revolution in Military Affairs (RMA). Confrontation with weaker states and nations, political aims to limit collateral damage, operations in urban environments, and the desire to enter into conflicts earlier to prevent escalation will be likely challenges for military commanders. The preparation, training, and equipping of the U.S military must be made with due consideration to the limitations and challenges posed by the battlespace of the future, as described previously. Military commanders must ensure that the US military and our allies are prepared to meet these challenges as we move into the new millennium, and non-lethal capabilities in support of urban operations must be seriously considered.

The Quadrennial Defense Review (QDR) and the CJCS Joint Vision 2010 (JV2010) Implementation Plan (JIMP) committed us to transform our military capabilities to meet the challenges of the twenty-first century. The National Defense Panel (NDP) on Transforming Defense—National Security in the 21st Century believes the United States must undertake a broad transformation of its military and national security structures, operational concepts and equipment, and key DoD business processes. This requires promoting fresh perspectives, fostering innovation and discovery through experimentation, and applying high-level analytic skills. Non-lethal technologies are introducing new dynamic opportunities to the future battlespace. One of the main reasons for addressing NLW was to provide commanders and policymakers additional options between *no* use of military force at all, and the use (or threat of use) of *lethal* force in *all* types of operations. This is a particularly difficult choice regarding urban operations where non-combatants, belligerents, displaced personnel, refugees, friendly forces, and enemy forces are so closely intermingled.

2. Joint Mission Area Analysis/Joint Mission Need Analysis

The Joint Staff recently completed a Joint Mission Area Analysis and Joint Mission Need Analysis (JMAA/JMNA) that analyzed the future threat environment, and identified the kinds of operations, including urban, in which US military forces may become involved. Among the findings of this effort were the following:

- Non-lethal capabilities have utility across all types of operations, from Military Operations Other Than War (MOOTW) to Major Theater War (MTW).
- Non-lethal capabilities apply across the hierarchy of joint and Service tasks, covering the strategic, operational, and tactical levels.
- Non-lethal capabilities have clear applications for tasks associated with Force Protection, Movement/Maneuver, and Employing Forces/Fires, with fewer applications for ISR and C2.

- Non-lethal capabilities complement lethal weapons and, for some tasks, offer advantages or unique contributions. This is true across the spectrum of threats and crises.

- Non-lethal capabilities provide a unique capability that allows forces to break the cycle of violence and revenge that provide the catalyst for prolonged or systematic conflict. This has significant implications for US forces conducting operations across the spectrum of conflict. Non-lethal capabilities support the accomplishment of mission tasks and operational needs in CINC war plans at the tactical level and have *potential* non-lethal application at the *operational and strategic levels*. Treaties and conventions developed prior to the advent of military non-lethal capabilities may restrict the development of selected technologies, e.g., calmatives.

- National policy and domestic laws may require review over issues of preemptive use, preclusionary use, or to prevent escalation.

- High technology NLW systems (i.e., lasers, millimeter wave) are necessary to provide required capabilties.

- Ranges of current NLW programs and systems only extend to 100 meters; however, the use of existing weapons systems still needs to be explored and examined.

Examples of where non-lethal capabilities address features within the complex urban environment and may offer advantages or unique contributions relative to lethal weapons include:

- attaining a military objective while minimizing unnecessary loss of human life and gross physical damage;

- countering the use of non-combatants used as human shields;

- achieving desired effects with precision accuracy on targets in restrictive fire areas or in constrained environments governed by Rules of Engagement (ROE) or treaty restrictions;

- reducing collateral damage;

- attaining counter-mobility and area denial (with advantages stemming from reversibility of effects);

- degrading weapons of mass destruction (WMD) production and delivery systems while reducing risks of nuclear, biological, and chemical (NBC) release; and

- Protecting forces and facilities.

The JMAA/JMNA strategy-to-task analysis confirmed the applicability of the three core capabilities (discussed next) with the associated eight functional areas. All of the core capabilities and their associated functional areas have utility or contribute to operations in urban environments and are listed as mission needs in support of a core capability. The Joint Non-Lethal Weapons Program will focus its efforts to finding solutions to the needs identified in the eight functional areas. The mission needs are the same non-lethal capabilities that support and contribute to the JFC requirements and provide for success in urban operations.

Counter-Personnel Mission Needs (core capability)

- **Control crowds. Mission needs include:**
  - control movement (stopping, dispersing, or channelizing crowds), to affect the crowd's perceptions (disorienting, confusing, deceiving, obscuring, or dazzling the crowd);
  - isolate or separate out individuals whether belligerents or "human shields" ;
  - tag or mark the crowd as a whole or specific individuals; and
  - influence the behavior of crowds.
- **Incapacitate individuals and groups.** Needs include the ability to:
  - distract, seize, render incapable of performing an activity; and
  - disorient or deceive both individuals and groups.
- **Deny an area to personnel.** Needs exist in both urban and open terrain to:
  - deny people access to (and movement within) buildings, facilities, structures, airfields, and hardened or buried targets; and
  - deny access to water, seas, oceans, and aerospace.
- **Clear facilities and structures.** Mission needs in this area include:
  - controlling entry to, exit points from, and the ventilation, communications, power, and water to facilities and structures;
  - the ability to empty or clear such facilities of personnel; and
  - the ability to separate combatants from non-combatants in and around facilities and/or to obscure the view of personnel occupying facilities.

Counter Materiel Mission Needs (core capability)

- **Deny an area to vehicles, vessels, and aircraft.** Mission needs include non-lethal denial means of:
  - restricting vehicle movement in urban or open terrain and vessels on the surface or submerged, specifically key infrastructure facilities and both natural and man-made terrain; and
  - being able to tag and/or mark vehicles.
- **Disable or neutralize vehicles, vessels, aircraft and equipment.** Specific mission needs for non-lethal capabilities address:
  - the disabling and/or neutralizing of railroad engines, automobiles, trucks, heavy equipment transporters, and military vehicles, to include armor;
  - A non-lethal capability to disable aircraft, vessels, and equipment without causing catastrophic damage was also specified as a desired capability.

Counter Capability Mission Needs (core capability)

- **Disable or neutralize facilities and systems.** Mission needs include:
  - a non-lethal capability for disabling and/or neutralizing electrical generating facilities, C4ISR systems, Integrated Air Defense System (IADS), weapon systems, optical sensors, electrical sensors, and navigation capabilities with such controlled effects as to allow for selective, precise engagement;
  - deceiving reconnaissance with illusions of barriers, obstacles, and/or forces, and concealing and/or covering friendly activities or movements particularly within complex urban terrain; and
  - modifying fuel or combustion materials is a supporting need.
- **Deny the use of WMD.** Mission needs include:
  - rendering a WMD inoperative,
  - containing the potential release of deadly agents and contaminants, and
  - preventing or neutralizing the production, storage, deployment (transport), employment, and delivery of WMDs.

  Non-lethal capabilities are desired that will permit engagement within populated or sensitive terrain and prior to the initiation of armed conflict.

3. Current and Near-Term Efforts

An integrated technology investment strategy for NLWs will be developed by the Joint Non-Lethal Weapons Program, one that focuses primarily on high-payoff technologies and takes advantage of opportunities across all three time periods. In the near term, the investment strategy will pursue the integration of existing or near-existing payloads into the numerous, already-fielded delivery systems and platforms to provide enhanced non-lethal capabilities at the tactical and operational levels of warfare. An opportunity that has not been examined but which may provide enormous support is the use of robotics to carry, deliver, or deploy non-lethal capabilities. At the same time, the Joint NLW Program will continue to invest in the development and maturation of less mature technologies that are likely to provide greater or more consistent effectiveness and standoff capabilities in the mid-to-far term.

No single system is likely to succeed in meeting all the requirements of any particular mission task or desired capability because of the inherently more benign nature of NLWs. Consequently, a sufficient number of non-lethal options will be developed to allow for the synergistic or multiplicative effects often garnered in a combined-arms approach. Finally, the Joint NLW Program places the highest importance on sufficiently characterizing the effects on human targets in the development of effective and credible non-lethal capabilities. Investments will be made to develop the resources and processes to efficiently succeed with this difficult but critical task.

The Joint NLW Program is investigating promising technologies that may yield new and advanced non-lethal capabilities for urban operations, among them:

- Active Denial System (ADS). The ADS is a directed energy counter-personnel non-lethal capability designed for area delay/denial and force/resource protection.
- Pulsed Energy Projectile (PEP). The objective of the PEP program is to develop a crew-served counter-personnel non-lethal directed energy weapon providing controllable bio-effects to deter, disable, or distract individuals.
- 81mm Mortar NL Munition.
- Objective Individual Combat Weapon (OICW) NL Munition.
- MK 19 NL Munition (Crowd Dispersal Cartridge-CDC).
- GVS. The Army Research Laboratory is developing the GVS which would use radio frequency (RF) energy to stop vehicles with electronic fuel controls at stand-off range without harm to driver and occupants.

In an effort to identify, develop, and evaluate alternative concepts that satisfy the mission tasks and needs identified from the JMAA/JMNA, the Joint NLW Program has funded six Concept Exploration Program (CEP) efforts. These are listed in Table IV-2 below.

These CEPs constitute a group of parallel, short-term efforts concentrating on defining and evaluating the feasibility of alternative concepts. Concurrent to various hardware concepts being evaluated, operational users from each participating Service jointly define the operational context, individual system operational concepts, and desired operational characteristics. The CEP process also produces the relevant documentation and establishes the foundation for selection of new acquisition programs.

CEP focus area	Service Lead
Clear Facilities (CFAC)	USMC
Area Denial to Personnel (AD-P)	US Army
Area Denial to Vehicles (AD-V)	US Army
Crowd Control (CC)	US Army
Incapacitate Personnel (INCAP)	USMC
Non-Lethal Slippery Foam (NLSF)	USMC

Table IV–2. Concept Exploration Program Efforts

4. Far-Term Efforts

The Joint NLW Program established the Technology Investment Program (TIP) to conduct initial assessments and evaluations of technologies with exceptional far-term payoff potential for NLW development. These short-term (one- to two-year) assessments are funded as a means to evaluate their potential prior to committing to larger, longer-term financial investments. In October 2000, a joint panel selected three new proposals for technology investment funding that will have applications in urban operations:

- **Thermobaric Technology for Non-Lethal Personnel Incapacitation.** The Thermobaric study will determine if this technology can provide a combination of tailored heat and overpressure effects to create non-lethal incapacitation.

- **Veiling Glare Effects of Violet Lasers.** The study of Veiling Glare Effects will explore recent advances in laser technology to determine if short wave violet lasers can disrupt vision even when the beam is not aligned with the visual axis.

- **Front End Analysis of Potential Riot Control Agents.** The Front End Analysis study will analyze potential alternative riot control agents and organize the results into a database for future assessments and evaluations in existing and new systems.

Other TIP efforts that are still under study and may provide future non-lethal capabilities are:

- **Extended Range Guided Munition (ERGM).** The ERGM study evaluated the feasibility for long-range delivery of non-lethal payloads.
- **Micro-encapsulation.** The Micro-encapsulation study was to develop counter-material and/or counter-personnel non-lethal capabilities that will use encapsulated chemicals in support of these functional areas.
- **Odorous Substances.** The Odorous Substances study investigated odorant payloads the their effects on human behavior and would be used in counter-personnel applicants or as taggants.

The need to extend the range of non-lethal capabilities was identified in the JMAA/JMNA. Efforts will be expanded to consider the use of robotics, including UAVs, or existing weapons systems to deliver and deploy non-lethal technology. Some systems under examination are the Non-Lethal Mortar Round and the Unmanned Powered Parafoil (UPP). However, only through a dedicated and focused Department of Defense S&T effort will the Joint NLW Program be able to pursue the development of a new generation of NLW that leverages twenty-first century technologies to capitalize on the full spectrum of non-lethal capabilities.

5. Conclusion

The Joint NLW Program recognizes that the needs and requirements of the future will most assuredly involve urban operations. The vision and major goals of the Joint NLW Program is the joint development and fielding of a family of non-lethal capabilities and systems applied across the full spectrum of military operations, and matched to the warfighter's requirements for the twenty-first century. The Joint NLW Program will ensure that the development of non-lethal capabilities is done in coordination with other capability assessments and the needs are identified for urban operations, psychological operations, information warfare, and force protection.

V. Key Directions for Improving Urban Capabilities: Operational Capabilities

The previous chapter described the landscape of programs and activities aimed at improving urban capabilities, and reviewed recent, current, and some DoD-proposed programs and activities (see Table IV–1). This chapter and the next one address the components of this landscape, and summarize key challenges and promising directions. The components of the landscape are broken out according to operational capabilities using the USECT scheme. and the Supporting Activities (DOTMLPF and additional categories). This chapter, in particular, addresses the operational capabilities and Chapter VI, the supporting activities.

A. Understand

The Understand component is the foundation for the others. If progress is not made in this area, then the new operational-level approaches will fail. We separate Understand into four sub-categories that address the physical environment, Red forces, Blue forces, and the strategic and cultural environment.

1. Physical Environment

Key Challenges

The fundamental challenge of the urban environment from a physical intelligence point of view is its sheer complexity. It is three-dimensional and includes subterranean structures, interiors of buildings and infrastructure systems. Current mapping capabilities provide a two-dimensional basis for precision strikes against fixed targets in a number of urban environments. However, the regions covered are limited, and three-dimensional, interior, and infrastructure data are generally lacking. Also, capabilities to rapidly focus data gathering, processing, and distribution (particularly down to small units) for developing situations are generally inadequate. In short, improved coverage and delivery time are necessary to support the new approaches.

There are two basic types of needed capabilities. The first is the ability to identify and rapidly search existing data sources, and the second is the ability to physically collect data. The first emphasizes information technologies, and the second, sensors (and the platforms that carry them). In both cases, improved methods of processing the data and communicating the results are critical.

Directions

Key intelligence programs for addressing the mapping of urban terrain are ongoing at the National Imagery and Mapping Agency, National Ground Intelligence Center, and Marine Corps Intelligence Activity. The Joint Warfare Analysis Center is conducting analyses of intelligence data to determine the structure of infrastructure systems as well as cultural mapping. The Army has an ongoing program addressing rapid terrain-visualization techniques.

The continuation and expansion of these activities will be necessary to address realistic scenarios and time constraints. The goal is to develop collection and analytical tools that can be rapidly focused on specific areas and that provide timely support to the JFC in an emerging situation.

Issues regarding the quantity, quality, and timeliness of information about the physical environment in realistic scenarios all involve the question, "How much is enough?" These issues must be addressed through experimentation activities.

2. Red Forces

Key Challenges

Given an understanding of the physical environment, the next critical component is to understand the locations, structure (including, e.g., critical points, information networks, and supply lines), movements, capabilities, and status of Red forces within that environment. These involve the acquisition, processing, and communication of information. The acquisition phase relies on sensors (in addition to other sources of intelligence such as human intelligence (HUMINT)), and the key challenges posed by the urban environment are the impenetrability of structures to conventional sensors and their resultant short lines of sight.

Another key challenge is to understand Red's overall goals, determination, tactical intent, cultural background, and morale. The overriding objective of urban operations is to reduce or destroy the enemy's will to resist; and a principal goal of improving capabilities is to achieve this with reduced casualties and collateral damage. Insight into the thinking and motivation of the enemy at all levels is therefore central.

The processing phase is also challenged by the complexity of the urban environment and the need to fuse a "synoptic" picture from large amounts of often disparate types of data.

Directions

There are several technologies that may help overcome, or at least reduce, the operational limitations of conventional sensors in an urban environment, particularly if used in combination.

- The first is to regain area coverage by distributing a network of short-range sensors that are linked in order to provide coverage of an extended area. Advances in sensors, miniaturization, information technology, and (perhaps unmanned) delivery platforms are making such capabilities more feasible. Such networks could be comprised of both ground- and air-based sensors. (Note also that a friendly population supplied with cell phones could form a very effective "smart sensor web"—a neighborhood watch on steroids.)

- A second approach of overcoming the limitations of sensors in an urban area is to use continuous ("staring") surveillance to construct an "activity map" of an urban area. Again, such sensors could be ground-, air-, or space-based, and could be coupled with sensors that monitor utility usage, are placed inside structures, or take advantage of the normal penetrations of structures.

- A third approach is to develop "through-wall" sensors that exploit radiation (electromagnetic or acoustic) that penetrates structures. For example, "CAT[1] scans" of structures may become feasible.

- A fourth approach, tagging technologies based on advances in miniaturization, is becoming increasingly feasible for the enhancement of signatures of personnel or materiel. Both *overt* placement on friendly forces and neutrals, and *covert* placement on hostile forces are possible.

Many of the technologies relevant to the above capabilities are under development. Further progress will depend on the expansion of such efforts, and the integration of the technologies into functional systems that include fusion, communications, display, and decision aids. Finally, these systems must be subjected to operational experimentation to guide further development.

In short, it is feasible that the fundamental limitations on conventional sensors imposed by the urban environment may be overcome at least well enough to give a significant advantage to a force that possesses them. Such sensor systems (which could include a number of the above methods) may also significantly reduce the advantage that accrues to a defender in an urban environment when only conventional sensors are available.

3. Blue Forces

Key Challenges

For the Blue forces, the principle challenge to understanding is the establishment of a reliable, secure, command, control, and communications (C3) system in the urban envi-

---

1 Computer-aided tomography.

ronment. Limitations on communications are central to this challenge: structures cause "dead zones" and multi-paths, and block reliable access to satellite systems such as GPS. These limitations are compounded by the intensity, pace, and immediacy of the enemy in urban ground operations, and the tendency of the urban environment to separate forces into small isolated units.

Directions

The establishment of reliable, local C3 networks that are linked to higher levels and that provide sufficient bandwidth for effective C3 is the primary means of maintaining an understanding of the locations and status of Blue forces. Such networks may be based on the ability to rapidly establish a network of transceivers that supports a local net and links it to higher levels. Tagging methods may also support the C2 process. Commercial developments in wireless communications are a central source of improved capabilities. Related current programs are those aspects of the Defense Advanced Research Projects Agency (DARPA) Small Unit Operations Program and the Army's Land Warrior Program that address the urban environment.

4. The Strategic Background and the Indigenous Population

Key Challenges

Understanding the strategic setting in any environment—but especially in urban areas—is extremely important. The more we know about foreign leaders, their relationships with other leaders, relationships with intra-government entities, business leaders, armed forces, non-state actors (transnational crime connections), cultures within states and alliances among those cultures, the greater the opportunities to resolve issues before the use of force is necessary to protect our national interests. This is an everyday effort whether at peace or war. As the spectrum of operations broadens to include lower-level conflict, determining strategic goals, desired end-states, and the interests of allies and the indigenous population has become a national-level challenge that has increased the burden on the JFC.

In some cases, such as a peace-keeping operation, civilian concurrence with JFC objectives may be central to mission success. In other cases, their needs may be a burden on a JFC's resources, or they may be openly hostile. In all cases, it is important that the JFC have insight into the culture, factions, locations, and capabilities of the local population. The lower the level of conflict, the more important this aspect becomes.

Far from practicing isolationism, the United States has had a policy of diplomatic, economic, and military peacetime engagement for some time now. Together with organizations such as the United Nations, the World Trade Organization, the World Bank, regional organizations (Organization of American States, NATO, European Union, Association of South-East Asian Nations), and multinational militaries, the United States has endeavored to understand the strategic environment. During the past decade, the

emphasis of these activities has shifted from the diplomatic and military activities between the United States and Soviet Union (the Cold War), to greater economic engagement and diplomacy through the United Nations.

The challenges to our capability to understand strategic settings include the lack of an ongoing process of cultural and/or political IPB (Intelligence Preparation of the Battlespace), a shortfall of human intelligence assets, insufficient resources for the Department of State, timely identification and confirmation of ambassadors, and immature relations between the interagency, Unified Commands, NGOs, and industry.

As an example of recent attempts to meet these challenges, the Defense Intelligence Urban Working Group, formed in 2000 under the auspices of ASD (C3I), has as one of its major focuses the urban population, including cultures, politics, key industry figures and non-political leaders, religious leaders, and criminal organizations. The goal is to provide future JFCs with a greatly enhanced understanding of the population they will operate among, so they can effectively shape it to support mission success.

The Unified Commands all have ongoing efforts to include other nations in seminars, exercises, and conferences (such as Pacific Command's EMERALD EXPRESS). Although these activities are largely military to military, in some instances representatives from the interagency, international governmental organizations (IGOs), and NGOs participate as well.

Directions

After the Cold War, instead of greater peace, the United States entered a period of New World "Disorder." Long-term conflicts in the Near East, Africa, the Caribbean, and the Balkans all serve as examples. We paid the price in American lives of misunderstanding the strategic setting in Somalia and, more recently, with regard to terrorists attacks at home. The need for greater human intelligence is widely acknowledged, particularly where urban areas are of concern.

During the past decade, US industry has greatly expanded into other parts of the world. Business people have become experts in the cultures and political realms in which they live. Yet efforts by those who conduct foreign affairs to develop relationships with US industry are limited. This is not to suggest that we use US private citizens as intelligence agents, but rather as information resources to help better understand the economic, cultural, and political environment.

Another key direction is to provide for leadership development that will enable future JFCs to be comfortable in such complex roles, and to create organizational structures dedicated to anticipating needs and responding to emerging situations in a timely fashion. Centralized resources for JFC access, with reach-out capabilities to established groups of subject-matter experts, could enable the JFC to efficiently access information

available from DoD, other US agencies, multinational partners, and NGOs. Such access should include the ability to leverage previously established relationships with friendly elements of the population in order to gain insight into local thinking and intelligence sources.

Other key sources of information critical to strategic decisions are regional organizations such as NATO, European Union, Organization for Security and Cooperation in Europe, Organization of American States, and Association of South-East Asian Nations. Efforts to establish deeper ties with these organizations should be undertaken.

Ambassadors represent the President of the United States. They lead a team of government representatives to include the interagency. They oversee US activities and interests in foreign countries and are "eyes and ears" critical to strategy decisions. Yet there are countries where we have diplomatic relations but have had no ambassador for periods up to two years. A high priority should be given to filling these vacancies and initiating relevant Civil Military Operations (CMO) when situations warrant other then armed intervention.

B. Shape

Shape capabilities enable the JFC to convert enhanced understanding into advantages over Red. It includes shaping the battlespace, degrading Red's position by restricting his situation awareness, mobility, support, and ability to effectively engage Blue forces. Shape also includes the enhancement of Blue's position by providing a robust and responsive information environment, force protection, mobility, and support. At its best, shaping can reduce Red's options to the point where engagement becomes unnecessary. Key elements of Shape address the restriction of Red options, the expansion of Blue options, and the control of the background environment (physical, political, psychological). Shape also includes creating an environment conducive to influencing and leveraging the indigenous population, controlling transportation and other elements of the infrastructure, and assuring a favorable strategic environment.

1. Shape the Battlespace

Key Challenges

Shaping the battlespace sets favorable conditions for engagement. The greater our capability to do so, the greater our ability to achieve success with less casualties to friendly forces and noncombatants, and less damage to infrastructure.

Shaping the battlespace includes activities such as constructing barriers (to physical movement and information), controlling/destroying/isolating physical nodes, or by constructing or repairing runways, ports, road/rail systems, or facilities. Currently, we have a fair capability to shape the battlespace, but to realize the full potential of the emerging approach to urban operations, capability gaps should be addressed.

The gaps in capabilities to shape the battlespace include barrier construction, general construction and repair capacity, capability shortfalls in nodal capture/destruction/isolation by special operations units, and the need for improved Information Operations to affect critical infrastructure. Several programs and activities initiated by the Joint Staff, Marine Corps, and DARPA address some of the shortfalls in our capability to shape the urban battlespace.

- One aspect of the Joint Non-Lethal Weapons Program is the development of barriers for controlling movement of both people and vehicles.
- The Marine Corps' Attacks on Critical Infrastructure Program is exploring the potential of information exploitation to affect critical infrastructure through non-kinetic means.
- DARPA's Distributed Robotics Program seeks to provide JFCs with additional means to shape the battlespace through the use of robotics to emplace/remove obstacles, deceive the enemy, or replace soldiers as a part of a unit tasked to capture/destroy/isolate a node.
- Another DARPA project, Small Unit Operations, is developing technology to give greater situational awareness, navigation capability, and linkage to precision fire systems, enabling soldiers to employ precision fires on high-payoff targets.

Directions

Shaping the battlespace is key to accomplishing the mission with as few friendly and noncombatant casualties, and unnecessary damage to infrastructure, as possible. Capture or isolation of key urban nodes will often be an important aspect of shaping the battlespace. Employing special operations or other units to accomplish this poses risk. Although there are existing programs that mitigate this risk, there are two technology areas where much greater focus and investment are necessary in order to make these options viable:

- The first is Information Operations. Computer Network Attack can paralyze or manipulate critical urban nodes without the use of ground assault to do so. Of concern though is potential opponents' capabilities matching, or nearly matching, our own. To keep one "step" ahead of our adversaries, considerable resources need to be devoted to Computer Network Attack and Computer Network Defense.
- The second technology that would give us a "leap-forward" capability is robotics. Robots can reduce the risk of casualties posed by close proximity to the enemy. By carrying sensors, communications equipment, or weapons, we can conduct small unit operations against nodes with lesser risk. Increasing our in-

vestment in robotics programs is a key to giving the future JFC greater capacity to shape the urban battlespace.

In order to shape the urban battlespace, the JFC may need to control certain urban infrastructure subsystems (e.g., public utilities, media or government facilities). This capability can be fundamental to success whether to preclude use by the enemy, repair for our use, or use by the civilian population. Little attention is being given to the utility of construction/repair capability in shaping an urban operation. Two ways of enhancing this capability might be considered:

- First, a base of expertise on foreign infrastructure could be established which could be "tapped" when needed. This could be done either through Civil Affairs Operations Centers (CMOC), or by establishing a "Knowledge Center" (like the National Ground Intelligence Center; or a network of experts electronically linked, including foreign/regional experts) for JFC "reach-back."

- The second aspect of enhancing capabilities for shaping urban infrastructure is equipment. Although we have ample construction equipment in our engineer units and construction battalions, it is not viewed as a "shaping" tool. Additionally, there is a lack of coordinating mechanisms and agreement as to the role of military construction capability and that of contracted construction facilitated by the interagency representatives deployed in theater. The result is lost time and/or opportunity.

2. Restrict Red Options

Key Challenges

The greater our capacity to shape Red to our advantage, the fewer friendly and noncombatant casualties, and infrastructure damage we will incur. Shaping capabilities that are most critical to the new approaches focus on the opposing force's understanding, mobility, support, and ultimately, his will to fight.

The abilities to disable the critical points of the enemy, and isolate or segment him are key. Such capabilities are critical in essentially all scenarios, and may be the ultimate objective in scenarios that preclude the introduction of large ground forces.

The isolation of Red includes countering the mobility of vehicles and personnel in order to fix them in position, partition areas, or create sanctuaries. It also includes the use of Information Operations to isolate Red by deception, prevention, or persuasion of either Red forces or the local noncombatant population.

The most significant shortfalls in our capability to shape opposing forces is our inability to determine who the opposition is, and where he is located, and what/where are his critical points within the urban setting. Additionally, when opposing forces and critical

points are located, we lack sufficient kinetic and non-kinetic means to shape/engage him without significant risk of friendly and noncombatant casualties, and damage to infrastructure.

Directions

Effective shaping of Red requires a high level of understanding of the urban physical environment, opposition forces, and noncombatant population. Given that level of understanding, shaping actions may be achieved with precision effects (lethal or non-lethal), Information Operations, or special forces.

Rapid-reaction precision strikes may be an effective counter to mobility if strike assets are coupled to a continuous surveillance system by a highly responsive C3 net. Additionally, the placement of survivable, autonomous or tele-operated, air or ground systems may be used as sensors and/or shooters to affect opposing force mobility.

A new direction in munitions is needed in addition to further development of non-lethal systems, sensor technology, unmanned systems, and computer network operations capability. Lower yield munitions, controllable trajectory delivery systems, and unmanned system-delivered weapons (both ground and air) will allow "stand-off" strike and less collateral damage.

3. Expand Blue Options

Key Challenges

The expansion of Blue's military options is addressed by capabilities to provide information, protection, mobility, and support. The provision of an information environment that overcomes urban limitations was addressed above in the Understand section. The remaining areas— protection, mobility, support—are addressed here.

Force protection may be achieved by:

- shaping the situation so much to Blue's advantage that engagement becomes unnecessary,
- engaging from outside the enemy's engagement range,
- using unmanned systems to detect, target, and engage, or
- using tactical advantages (stealth, ballistic protection, speed, and surprise.) if close-up engagement is necessary.

Lacking these, urban conflict reverts to the traditional high-casualty, close-up fight.

The capability to engage from beyond the enemy's engagement range is enabled by accurate reconnaissance, surveillance, target acquisition, and tracking capabilities linked to responsive fires by a reliable C3 system. Such capabilities form the basis for the new approaches and are addressed in the Understand and Engage sections.

Unmanned systems may have varying degrees of autonomy. The principal challenges are survivability, mobility, and sensor and engagement capabilities in an urban environment.

The difficulty in gaining tactical advantages in close-up ground operations in urban areas (particularly while on the offensive) is the fundamental challenge of traditional urban conflict, and continues to be a primary focus of development activities.

Rotary-wing aircraft, ground vehicles, and personnel are all vulnerable to ground fire (including rocket-propelled grenades and man-portable air defense systems).

Aircraft, ground vehicles, and personnel all face mobility challenges in urban terrain where structures and obstacles are compounded by close-up threats. Rotary-wing aircraft are vulnerable in the confined spaces between buildings or power lines. Vehicles designed for open terrain with an emphasis on speed, frontal armor, and long-range sensors and weapons do not fare well in an urban environment. Personnel mobility in an urban environment must be three-dimensional—either inside, outside, on top of, or underneath structures. Logistics is difficult to maintain because of the difficulties in securing routes and the high consumption rates that are common with urban ground operations. The support of dispersed ground units would further exacerbate this challenge. Medical support provides a special challenge since one-way transportation (e.g., by parafoil) does not apply to that case.

Directions

The potential of unmanned systems for urban conflict is just beginning to be explored. Technologies for robotics, information, miniaturization, sensors, materials, power sources, and others all come together in these systems, and all of these technologies are advancing rapidly. Such systems may be ground- or air-based, small (e.g., to emplace miniature sensors) or large (e.g., for supply transports or medical evacuation), single or networked, autonomous or tele-operated.

Directions for the improvement of tactical force protection include lightweight ballistic protection, exoskeletons, capabilities for detecting mines and booby traps, and vehicle-mounted systems that automatically detect and counter-fire against snipers.

The issues of force protection and mobility in an urban environment are daunting. Some progress is being made by introducing new technologies (e.g., MOUT ACTD; see Appendix A of this volume for details), new tactics (PROJECT METROPOLIS), and better training. However, progress is incremental. The challenges of force protection and mo-

bility associated with the traditional approaches to urban ground operations are the primary motivation for pursuing the new approaches.

4. Influencing and Controlling the Strategic Background and the Indigenous Population

Key Challenges

The challenges identified in understanding the strategic background and indigenous population are all applicable in shaping. The essence of successfully shaping the strategic landscape and indigenous population is understanding the politics, culture, economics, and formal and informal alliances. Civil Military Operations provide a means of interacting with foreign governments and enhance the ability of joint and coalition forces to interact effectively with host nation officials and organizations. The JFC must interact constructively and effectively with US agencies, multinational partners, international organizations, NGOs, indigenous population organizations, and industry. Ready access to such organizations must be routinely available, and the JFC must have the skills to effectively exploit such access.

Shaping activities addressing the indigenous population should first be aimed at assisting local authorities (to the extent that they exist). This includes upholding the rule of law (law enforcement and judiciary), supporting food and clothing distribution programs, infrastructure repair, restoration of emergency services, and coordination and/or support to international governmental agencies and NGOs. Critical to all these activities is a well-orchestrated public information plan within the Information Operations campaign (e.g., media affairs, Computer Network Attack/Defense; Psychological Operations).

In addition to those capability gaps cited in the section addressing "Understand: The Strategic Background and Indigenous Population" (page V–4), shaping shortfalls include a cumbersome interagency process, multinational military interoperability problems, and immature relationships with international and regional organizations and NGOs. In addition, there is no multinational doctrine that governs activities dealing with the civilian populace. There is a significant lack of education and training regarding civil affairs between the military, government agencies, and NGOs. This is true at both the national and international levels. Finally, there is a lack of understanding of how important urban populations are, not just to military mission success but to longer-term multinational "exit" strategies.

Current efforts to develop capabilities to shape the strategic environment and influence indigenous populations are not robust. Unified commands invite other nations to participate in conferences and exercises, but participation has been modest. Likewise, some efforts are made to partner with government agencies and NGOs, but development of these relationships has not been a high priority within DoD.

Most of the recent and current progress in dealing with urban populations during contingencies is occurring in academia. Numerous universities sponsor conferences and symposia on civil affairs and civil-military issues. DoD is engaged with some university programs and has initiated organizations and programs as well. The National Defense University, the US Army's Peacekeeping Institute, and Unified Commands are examples. The State Department has also expanded its relationship with these organizations and with NGOs as well.

There is one effort supported by the Office of the Secretary of Defense that is specifically targeting this issue. Congress and the Office of Naval Research funded an organization named the Center for Threats and Emerging Opportunities to address strategic political-military planning and the links between the strategic and operational levels of war. PROJECT LINCOLNIA was a recently conducted exercise that, for the first time, linked an interagency political-military planning process to a joint experimental headquarters and tactical-level exercise and simulation experiment—all in a common urban scenario. Lessons were beneficial in identifying issues central to understanding and shaping the strategic setting. Follow-on LINCOLNIA types of projects will further explore these issues and identify remedies.

Directions

The rapid growth of NGOs and private voluntary organizations (PVOs) has become both a challenge and an opportunity for our Unified Commanders and interagency, particularly when considered in urban environments. The knowledge level that these organizations attain could contribute a much greater depth of understanding to our decision makers. Yet we have not fostered the kind of relationships that would allow this to happen. Incorporating NGO representation into the interagency (the US Agency for International Development, for example), greater interagency representation in the Unified Commands, and greater participation by the interagency and NGOs in Combatant Command exercises would build relationships and develop capabilities to shape the strategic environment.

Currently, the regions of the world associated with our Combatant Commands do not match up with regions established in other agencies. For example, some Combatant Commanders have to coordinate with as many as four State Department regional bureaus. Some State Department bureaus have to coordinate their activities with as many as four Combatant Commands. Realignment of regions to simplify coordination would streamline the interagency process and enhance our ability to shape the strategic environment.

Leader development must include professional military education addressing the needs of the JFC in a multinational, interagency, and NGO environment.

Reach-back systems for ready access to interagency and multinational expertise must be available to the JFC.

From a systems perspective, the same types of capabilities that are needed to shape Red's environment may also apply to the abilities of the Blue forces to influence, leverage, or support the noncombatant population. Systems could include:

- Information systems that control and exploit existing infrastructure such as local television or radio stations
- Secure cellular communications
- Automatic translation devices
- Rapidly assembled shelter and care facilities
- Means of planning and conducting information operations to empower and support friendly civilians

Doctrine regarding the shaping of the strategic background needs to be integrated. Joint Publications on Civil Affairs, Multinational Operations, Interagency Coordination, Information Operations, and Public Affairs mention each other, but predominately focus on their central theme *in isolation of integration issues*. The effect of this "stovepipe" approach is observed in current and recent contingency operations where coordination of these activities has been problematic. These publications should be expanded, or a new publication written to discuss the "why" and "how" regarding integration.

No multinational doctrine exists in dealing with noncombatant populations. Commanders have conducted their operations according to policy guidance and adaptation to each given situation. This has taken precious time that otherwise could have been used more advantageously.

C. Engage

Engagement capabilities are required that enable Blue to follow up on the understanding and shaping components by acting decisively, yet with precise and restrained effects, so that civilian casualties and collateral damage may be significantly reduced. We look at three aspects of engagement: weapon delivery for various types of targets, weapon effects, and unconventional engagement (Information Operations and Psychological Operations).

1. Weapon Delivery

Capabilities for two-dimensional targeting of fixed targets with kinetic weapons have been achieved. However, additional capabilities are needed to support the new approaches to urban operations.

Key Challenges

Some key challenges to weapon delivery in an urban environment are rapid response to time-critical targets; precision attack where structures may interfere with trajectories or approaches; three-dimensional targeting; moving targets; and underground targets.

Directions

Some key directions for addressing these challenges are target tracking/tagging, rapid C3, and quick-response weapons with autonomous redetection capabilities (such as loitering weapons) for time-critical targets; variable-trajectories for difficult-to-reach aim points; and penetrating warheads for underground targets.

2. Weapon Effects

Controlled precision effects offer the best hope of reducing civilian casualties and collateral damage. Effects may be anti-personnel, anti-materiel, or anti-system (transportation, information, infrastructure).

Key Challenges

The key challenge is to generate the desired effect while reducing friendly and noncombatant casualties and damage to infrastructure. Another is determining post-attack effectiveness. The use of some weapons, such as chemical calmatives, would require policy changes.

Directions

Methods include physical, chemical, informational and psychological. Examples of the first two types include directed-energy weapons (both electromagnetic and acoustic) to control personnel or disable vehicles; chemical agents (such as calmatives) to clear buildings or to engage an enemy who is among noncombatants; soft projectiles; obstacles; sticky or slippery foams; and anti-vehicular traps. In addition to non-lethal means, lower yield kinetic munitions would also support more focused effects.

3. Information Operations and Psychological Operations

Information Operations and Psychological Operations are also included among effects generation. The control of Red's information environment or a city's infrastructure, us-

ing information attacks either alone or in support of other operations, may be critical to achieving military objectives with reduced unintended consequences.

Key Challenges

Key challenges to information operations include achieving sufficient knowledge of systems to control them, and the informational analogue of BDA (battle damage assessment). Information and Psychological Operations are well suited to the urban environment if based on solid cultural understanding and if integrated with other aspects such as public affairs and civil affairs.

Directions

Key directions are to develop the technical tools of Information and Psychological Operations, and the abilities to effectively apply those tools in likely cultural environments.

D. Consolidate

Consolidate focuses on the end-state for the combat force: securing captured areas against re-infiltration, and restoring infrastructure, law and order, and services.

Key Challenges

Key challenges during the consolidation phase are the large numbers of forces required to maintain the security of an urban area, and the possible need to restore basic services to the population. The first of these will tie up combat forces and slow down the progress of the campaign. The second will stress support and supply resources.

Directions

A new organizational approach could relieve combat forces of consolidation and transition duties. A force analogous to the Army Corps of Engineers could relieve the combat forces as soon as possible and provide for post-conflict security and recovery. Such a corps could also perform humanitarian assistance and peacekeeping missions in lesser contingencies through effective use of Civil Military Cooperation (CIMIC).

In the Materiel category, Consolidate shares several technology enablers with the previous components, but with the advantage that the Blue forces would deploy systems in areas that are controlled by Blue. Systems and technologies include:

- Techniques for creating physical barriers such as wire, foams, or non-lethal weapons including directed-energy beams or chemical irritants.
- Autonomous sensors and robotics for monitoring buildings and areas, performing sentry duties, and conducting reconnaissance patrols.

- Systems that support the reconstitution of infrastructure (such as water, power, and transportation) and provide for the basic needs of the population (food, shelter, and medical) should be pursued.

E. Transition

Transition focuses on the return of control to civilian authorities.

Key Challenge

The key challenge is to replace the occupation force with a stable government that is capable of providing basic needs. Capabilities described above for understanding and shaping the strategic background and noncombatant population are central. Effectiveness depends on the abilities to coordinate with agencies, allies, NGOs, and local authorities.

Directions

As discussed above, leader development, and efficient reach-back to information sources and expertise are key elements.

Many of the capabilities required for Consolidate and Transition are similar to those addressed above for the other components (establishing defensive perimeters; surveillance nets; unmanned systems; coordination of coalition, interagency and NGO activities; interacting with the local populace). Other capabilities are more specialized such as engineering capabilities for the restoration of infrastructure, support facilities for noncombatants, and "government-building" capabilities of civil affairs units. However, these capabilities do not loom as potential "showstoppers" if the earlier (Understand, Shape, Engage) challenges can be met.

VI. Directions for Improving Urban Capabilities: Supporting Activities

This chapter addresses directions for supporting activities aimed at improving joint urban capabilities at the operational level. The activities are listed according to the following categories:

Doctrine	Leadership	Coalition and Interagency
Organization	People	Concept Development and Experiment
Training	Facilities	Modeling and Simulation
Materiel	Policy and Legality	

In each case, key challenges and key directions are addressed.

A. Doctrine

Key Challenges

As with other warfighting areas, doctrine forms the basis from which urban operations are planned and executed: *it is the glue that links current military capabilities to methods of employment*. As such, doctrine represents the foundation of, and is often times the catalyst for, meaningful change in other DOTMLPF areas.

With regard to urban doctrine today, Army and Marine Corps efforts are primarily focused on tactical-level urban operations in the context of today's strategic environment. However, current operational-level doctrine remains virtually identical to that of World War II. The accepted method for addressing urban areas remains one of avoidance; and when avoidance is not possible, intelligence, surveillance, and reconnaissance (ISR) and firepower capabilities designed for open environments are adapted for urban use. Therefore, because urban areas significantly limit the current suite of ISR capabilities, the emphasis is necessarily placed on using firepower to both discover and then engage enemy forces. The result is more often than not, slow, methodical, linear operations characterized by heavy friendly and noncombatant casualties as well as significant collateral damage to buildings and infrastructure.

DoD-wide agreement that current urban doctrine is either lacking or in desperate need of revision has lead to recent efforts to address these issues:

- As previously mentioned, both the Army and Marine Corps have recently or are currently updating ground-force tactical urban doctrine.

- Simultaneously, efforts are underway to address doctrinal shortcomings in urban Intelligence Preparation of the Battlespace (IPB), and aviation tactics, techniques and procedures (TTPs) in Air Land Sea Application (ALSA) publications.

- From a strategic perspective, the Joint Staff has lead an effort to develop, for the first time, *Joint Urban Operations Doctrine* (JP 3-06) to address joint, operational- and strategic-level needs of the JTF commander.

All of these efforts have not only begun to improve the quality of previous urban doctrine, but have also begun to reverse the tendency to accept the premise that simply using improved open-warfare, conventional, tactical and operational firepower in urban areas can adequately address such complex contingencies. As a result, new reasoning is now being applied to operational-level concerns and joint force capability requirements regarding urban operations.

Directions

Although significant improvements seem likely in each of these areas, current efforts are also identifying substantial obstacles yet to be resolved. For example, in the IPB arena, although the urban environment is vastly information intensive, much of the required data will be of use to only certain recipients—a situation that threatens chaos unless a supportive information architecture is developed that displays information in a useful manner. The current urban IPB doctrinal effort has highlighted the need for an automated IPB process that can distribute real-time customized slices of information to the right user, at the right time, and allow that user to also input data into the information base.

Additionally, because doctrine is the fundamental guide for training, equipping, and operating the force, more needs to be done to ensure current publications are updated and adapted so that lessons learned from actual operations and experiments are included. Currently, too little is being accomplished (especially in joint doctrine development) in this area. Although the Chairman's Remedial Action Program represents an appropriate approach for accomplishing this, current input to the Joint Center for Lessons Learned (JCLL) is voluntary and therefore not robust enough to be as useful as it could be. To remedy this situation, detailed After Action Reports (including interviews) on both real-world operations and experimentation related to urban operations should be made mandatory. Additionally, the JCLL should be directed and adequately resourced to not only ensure detailed lessons learned are captured from these activities, but that they are included in future urban doctrinal revisions.

Furthermore, due to the likelihood that when called upon to do so, US forces will operate as part of an interagency and multinational force in urban areas around the world, much more needs to done to include interagency and multinational input (e.g., NATO, Partners for Peace) within doctrinal development and revision. This doctrine sharing

will not only enhance our ability to operate more effectively as a member of a joint, interagency, multinational task force, but it will also significantly influence and assist with complex issues related to materiel standardization and interoperability.

Moreover, there is a need to address DOTMLPF changes in a more holistic system-of-systems approach, one which allows for adaptive and rapid change across all of DOTMLPF when significant opportunities for improvement are discovered in any one of the separate areas. Developing such an adaptive process will require a new approach with top-down guidance, which would necessarily also address issues related to rapid acquisition and fielding.

B. Organization

Key Challenges

There has been some debate regarding the possible need to develop specialized units organized, trained, and equipped specifically to conduct complex urban contingencies. Although not detailed in scope, these discussions have nonetheless begun to identify and clarify arguments as well as possibilities associated with how the DoD might organize differently to best meet the challenges associated with the complexities of urban operations. The traditional view is that units should not be specialized for urban operations because of the myriad of non-urban missions which current forces must be prepared to conduct. Predicated on the belief that urban areas are but one of a number of environments in which general-purpose forces should be trained to operate, the suggestion is often heard that current force structure does not currently identify specialized units for other environments like jungles and deserts, and therefore should not do so for urban environments either.

Countering this argument is the view that world events have drastically altered the current state of affairs, and today urban operations are too likely, too difficult, and too complex to simply do business as usual. This argument is supported by suggestions that, despite the rhetoric of the traditionalists, most units are already specialized to operate in areas other than urban and that the status quo must change if true improvements are to be realized. Examples cited include armored divisions for armored warfare in deserts and other open areas, arctic units for cold weather operations, and the 10th Mountain Division, which is even named after the environment for which they train. Furthermore, the argument goes, even the non-ground services organize by specialty, for example, amphibious forces for amphibious operations; surface and subsurface forces for their specialties and air superiority and air transport. These examples are then used to postulate that the urban environment is the *only* environment that does not have specialized units, or at least concentrated specialized schools, and that is one reason why improvements have not kept pace with open warfare capabilities in the first place.

Although not much has been done to seriously address the area of organizational change related to urban operations, a 1986 Defense Science Board (DSB) study[1] did focus on the issue of the transition from wartime to peacetime reconstruction in urban areas. After highlighting the difficulties associated with identifying and marshaling the appropriate mix of interagency and civil affairs expertise required for such complex endeavors, and following considerable thought and deliberation, the DSB recommended that the Corps of Engineers be given this task and authority to draw from a number of sources inside and outside of the Corps the needed assets and personnel. Despite the fact that the Corps of Engineers has resident within its organization the wherewithal to accomplish the task recommended, no effort to enact such an organizational change was adopted. Based on this past decade's operational experience in the Balkans and other regions of the world, it would appear that it is once again time for DoD to take another serious look at this issue as well as the Active versus Reserve mix of civil affairs units.

Directions

At the crux of the organizational issue is whether or not urban complexes should be viewed as an *environment* in the traditional sense or as a *mission area* as some reformists suggest. The contemporary Service view is that it is undesirable and inappropriate to look at the urban area as anything other than an environment. This argument suggests that, as in the case against specialized units, urban areas—while perhaps more complex—are nonetheless environments like the arctic, the jungle and the desert, and should be addressed similarly by simply adapting current capabilities to each environment as necessary.

Counter to this position is the suggestion that it is an invalid comparison to balance the likelihood of occurrence, the complexities, and the value of urban areas (which not only contain the most complex terrain but also are teeming with noncombatants) with arctic and jungle environments. Unlike other environments, operating in complex urban areas is fraught with far more complex dangers. Examples include not only the risks of high friendly and noncombatant casualties as well as the probability of significant collateral damage, but also the very real probability of second- and third-order effects, which could have strategic and global implications. *And it is precisely because of these factors that reformists view current legacy force capabilities built for open warfare woefully inadequate to simply apply to urban areas.*

To identify and acquire the capabilities needed to adequately address the coming urban challenges will require a paradigm shift in the way we currently think about urban operations. *The shift would include changing the current practice of addressing urban operations as simply*

---

1 US Department of Defense, Defense Science Board, *Conflict Environment Task Force (Implications of Third-World Urban Involvement*, May 1986.

another environment to one that addresses it as a mission area. This change would bring to the forefront two things that have been missing from the urban landscape to this point: adequate levels of attention and resources. Completing the paradigm shift would be the realization that in the near future, current legacy forces would begin to reorganize and restructure with capabilities for urban operations and adapt those capabilities for use in the desert, arctic, and jungles if/and when necessary.

An additional organizational challenge associated with urban operations is shared by some of the new approaches proposed for ground warfare in general: the use of small, distributed units rather than large formations. The urban environment tends to naturally reduce a large force into isolated units, and the potential for empowering such units with improved ISR, connectivity, and remote fires places increased responsibilities on the small-unit commanders who may now have considerable joint assets available to them. This raises fundamental questions regarding the organizational structure of forces for urban operations, and the types of personnel within them.

C. Training

Key Challenges

Training of basic skills and other individual and small team tasks is independently defined through individual Service training requirements based on doctrine and TTP that, in the case of urban operations, are somewhat unique to each Service, dated, and not tied to joint capabilities. While various Service-level warfighting studies, experiments, and demonstrations have identified new technologies, doctrines, and TTP, they have not yet been matured or implemented through formal documentation. Nor are they cohesively tied to joint doctrine and TTP that are only now emerging. Most training today is limited in many ways to doing business in the traditional, long-evolved manners, and focused on tasks drawn from past urban experiences.

All Services are in the process of reviewing urban operations documentation and procedures from doctrine on down, and in some cases have undertaken active development of tasks, training requirements, etc. The recent (within the last two years) invigoration of urban considerations across the entire spectrum of military operations has lead to the parallel developments and activities within the Services, which require increased levels of coordination and cooperation. The goal is to emerge from this era of urban operations review, analysis, and update, with tightly linked Service and joint doctrines, and TTPs that lend themselves to seamless and flexible integration of joint (and interoperable) forces.

Urban operations interoperability training endures all of the same constraints as interoperability training in general. Conducted only after Services' core training requirements are completed, OPTEMPO (operation tempo) and resources usually preclude much, if any, cross-Service training. Interoperability tasks are only recently emerging and are yet

to be turned into accepted training tasks, conditions and standards. Because interoperability requirements were not levied in the development of existing facilities, few can even support large-scale interoperability exercises or provide the connectivity to accomplish interoperability or joint training in a distributed manner. While target arrays for air-ground operations are being developed by the Air Force and Marine Corps, little is being accomplished to integrate air and ground operations.

Recent experiments and demonstrations have added credence to the direct relationship of effective combined arms and reduced casualty rates. Effective coordination and employment of all variations of firepower, frequently crossing Service boundaries, have increased and validated the efficacy of joint and interoperability training. Concurrent with Service development of doctrine, TTP, tasks, conditions, and standards of training, the Joint Urban Working Group has been developing joint and interoperability products, similar to those under development in the Services. A study (yet to be released) of Joint Urban Operations Training has been addressing facility requirements and developing an inventory of existing and planned facilities. As this effort culminates, a clearer picture of joint and interoperability training requirements and associated facility requirements will emerge.

The requirements for training a JTF staff to conduct military operations in an urban environment can be addressed through the use of Professional Military Education (PME), experimentation, and training venues. Activities may include seminar-based wargames, professional writing papers as part of PME; experimentation on new aspects of DOTMLPF, and OPLAN (operation plan) development and refinement of unique TTP as part of training.

Using the construct of the Joint Training System (JTS) as defined in the Joint Training Manual (CJCSM 3500.03), the Joint Staff is addressing training requirements, plans, execution, evaluation, and assessment.

Combined Joint Force (Joint Task Force (JTF) Staff, Component Staffs, and Assigned Units) Training—the ultimate, albeit unusual, training event—is the opportunity to simultaneously activate the entire JTF in a training exercise. This could include many variations of live, virtual, and constructive simulation elements in combination, in order to place the entire force in a common training environment. Or more simplistically, the JTF can be simultaneously fielded to live exercise area(s). Due to funding and OPTEMPO/personnel tempo (PERSTEMPO) restrictions in recent years, this has been a very unusual event. The future of linking distributed elements of local live, virtual, and constructive elements is in breaking down constraints; and as interconnecting venues become more common, so will the occurrence of total task force training. The in-progress Joint Urban Operations Working Group (JUOWG) Joint Training Study is developing a cost analysis of selected total task force training options; the preliminary conclusions from this unfinished effort suggest a heavy reliance on live exercise opportunities. With the maturation of virtual and constructive options, the cost-effective solu-

tions are likely to migrate toward virtual and constructive as they become more prominent and available.

The US Joint Forces Command (USJFCOM), as the lead for Joint and Interoperability Training and Joint Experimentation, is the logical choice to address urban operations as it pertains to JTF staffs and interoperability training events. *Unified Command Plan 99* identified several areas for USJFCOM to address as the lead agent for joint training management, system support, staff training, interoperability training, scheduling and deconfliction, distributed joint training, modeling and simulation, and doctrine development.

For experimentation, the Unified Command Plan directed USJFCOM to address Rapid Decisive Operations (RDO); Attack Operations Against Critical Mobile Targets (AOACMT), Common Relevant Operational Picture (CROP), Adaptive Joint Command and Control (AJCS), and Joint Interactive Planning (JIP).

This guidance rationalizes a direct role, if not a role of leadership, for USJFCOM in many areas across the full dimension of urban operations and training. Due to the concurrent nature of the development of joint doctrine (JP 3-06), Service doctrines (such as FM 3-06 and others), joint and Service level TTP, tasks, and training requirements, there is a need for validating the cohesiveness of the resultant strategy and the effectiveness of the emerging capability across the joint spectrum. Appropriate exercises and experiments must be conducted to accomplish this sanity check on a recurring basis as the Department continues to mature the many emerging elements associated with the urban environment.

Directions

The Joint Staff should ensure that joint and Service urban operations doctrine, TTP, and joint/interoperability tasks meld cohesively into a coherent joint warfighting strategy.

USJFCOM should ensure that interoperability training requirements are adequately identified, resourced, and scheduled; and that training is conducted to satisfy the requirements. Also, USJFCOM should address urban operations at the JTF staff level, and should research whether urban operations are adequately addressed in the Universal Joint Task List (UJTL). Additionally, USJFCOM should conduct experiments and training events involving urban operations for JTF staffs.

Both the Office of the Secretary of Defense of Personnel and Readiness OSD (P&R) and the Joint Staff should facilitate the development of the facility and instrumentation categories of the JTTRR (Joint Test and Training Range Roadmap); that they are established and presented to the DTTSG (Defense Test and Training Steering Group), and incorporated into the annual update cycle. Additionally, OSD(P&R) should mature the

urban operations facility elements within a web network, to be determined in the near future.

The JUOWG and OSD Urban Working Group (OSD WG) need to facilitate high levels of coordination, information sharing, and activity visibility among the Services, OSD, the Joint Staff, and Combatant Commanders, as well as other interested agencies.

D. Materiel

Materiel developments can spark changes in DOTMLPF leading to major improvements in capabilities. Progress can be made at three levels: systems development, science and technology (S&T), and systems acquisition. Approaches that offer the potential for major improvements in urban capabilities are, in general, unproven and therefore not ready for materiel acquisition. We therefore focus here on system development and S&T. Linkage to the *OSD Urban S&T Roadmap* is discussed in Volume II, Appendix F.

Key Challenges

Challenges for system development follow from the required USECT capabilities discussed previously in Chapter V. Some important directions are summarized below.

Directions

Understand. The critical directions center on automated search and mining of existing databases; 3D mapping; sensors and platforms that are effective in an urban environment; networked, staring, activity sensors (movement, utilities usage); through-wall sensors; tagging sensors; means of identification (friend, foe, and noncombatant); and information fusion-processing-display decision aids; urban C3; position location; and reach-back.

Shape. Enhanced systems for Information Operations are needed. Also, the development of anti-personnel and anti-vehicle barriers should continue, along with unattended sensors and weapons (lethal and non-lethal). Survivable ground vehicles and rotary-wing aircraft and ballistic protection for personnel (and vehicles) are necessary as well as chemical and biological protection, counter-sniper systems, mine and booby trap detection and neutralization, ground force support systems (including medical), and unmanned systems (RSTA, engagement, support).

Engage. Enhancements are needed in standoff precision engagement, rapid sensor and shooter links, variable-trajectory weapons, engaging moving and buried targets, reduced-effects kinetic munitions, non-lethal effects (directed energy and chemical), and BDA for non-lethal effects.

Consolidate/Transition. Sentry systems, barriers, systems that enable the restoration of infrastructure, and more closely integrated civilian-military relationships are all promising areas for improved capabilities.

Required directions in S&T include robotics (ground and aerial), miniaturization, sensors, ballistic protection, exoskeletons, new power sources, non-lethal effects, and protection from chemical, biological/, and radiological threats.

E. Leadership

Key Challenges

Urban conflict presents unique challenges to the JFC due to the complexity of its physical environment, its human dimension, and the likely involvement of interagency and multinational interests. There is currently little or no formal preparation available to prospective JFCs on urban conflict.

The National Defense University and the nation's war colleges provide a unique forum for lectures, discussions, debate, and instruction that shape the thinking of future leaders. Each school's Program of Instruction (POI) has the potential to significantly encourage and reinforce change within the Leadership element of DOTMLPF. Because these institutions produce the future leaders within the military, there is community-wide consensus that formal academic POIs should include urban-related topics within their programs for both Joint and Service-specific Professional Military Education (JPME and PME).

While such formal JPME is not in place today, it should be noted that the increased emphasis related to the topic of urban operations within DoD has not gone unnoticed at the formal schools. Within the past year, each senior Service school has begun to address this issue with differing degrees of emphasis and focus. Both Army and Air War Colleges already have Service electives and/or other classes addressing urban operations, and there are plans to do the same at National, Naval and Joint Forces Staff College within the next year.

Although efforts undertaken recently represent an important step, for the most part these efforts are focused on Service-specific issues and therefore tend to neglect the strategic and operational imperatives that urban operations will have on joint operations. In an effort to better identify and address these JPME-related and other PME-related shortcomings, each school has assigned a point of contact (POC) to take part in an effort to share, collaborate with, and possibly leverage ongoing urban-related academic activities at the other senior Service schools.

As a first step towards collaborating and leveraging, a meeting of representatives from the schools and other related organizations was held at the Army War College in May 2001. Initial results included an agreement among the attendees that action should be

taken to address the issue, and each agreed to approach and recommend to their school leadership that they support and be members of an Urban PME implementation team to find solutions to the urban PME shortcomings.

At a second meeting, held at the Naval War College in October 2001, the team formulated a proposal that urban operations be assigned as a Special Area of Emphasis (SAE), which would require formal development of urban operations JPME. The Naval War College agreed to be the lead school in advancing that proposal. As a follow-on endeavor, the team will also attempt to come to grips with, and help build, a strategy to address the lack of a PME/JPME-type instruction process for interagency political-military planners.

Directions

The creation of formal programs of instruction at the joint, Service, and interagency senior schools would help to address this challenge regarding the unique demands of urban operations.

F. People

Key Challenges

Even if new approaches to urban operations are developed, there will still be situations requiring a manpower-intensive close fight, and this means casualties are likely to be heavy. Training is key, but it is time consuming, and skills are perishable. Even the best trained are still susceptible to heavy losses (Hue and Mogadishu), and tactical effectiveness affects strategic goals.

Directions

A source of urban expertise is resident within the US military but not acknowledged or leveraged. Every year thousands are recruited from the cities of America to serve as soldiers, sailors, airman, and Marines. Yet the talent and experience resident within this population is not viewed as a resource to be tapped for urban operations. In fact, it is not uncommon to take these city dwellers, from places like Brooklyn, Los Angeles, or Atlanta, and immediately introduce them to the swamps and woodlands the likes of Parris Island, Camp Lejeune, Fort Jackson for training. So a case can be made that prior knowledge of the urban environment can be recruited for and leveraged in preparing forces for urban conflict.

G. Facilities

Key Challenges

Facility requirements have long been established to address Cold War training requirements, which resulted in a distinctive image of central European "villages." The facility designs were predicated on these dated requirements and resulted in a restrictive small-unit (company and below), "infantry only" training environment. Shortfalls have been identified in the areas of large-scale (battalion and above) facilities that are combined-arms capable (particularly air and armor), interconnectable, joint, and interoperable, with diverse environments (e.g., high rise, industrial, subterranean, littoral, industrial). There are no congruent ground-and-air facilities with adequate air space for employment of (simulated) modern weapons using current tactics. Little instrumentation is available to capture training activity and performance for post-training review, resulting in inefficient training of questionable validity.

Maneuver (tracking), target, and data collection instrumentation has not evolved as rapidly as that found at Major Training Centers. "In-building" constraints to visual, laser, and radio frequency technologies has made instrumentation less effective and more costly (higher density) when applied to urban environments. Hence, few facilities are instrumented, and the level of instrumentation is limited to video recording, basic targetry, and some special effects (sound and explosives). While government and industry is exploring more applicable instrumentation technologies, system-level requirements are being defined.

Recent improvements have been evidenced, particularly in the Army, Marine Corps, and Air Force:

- A Combined Arms MOUT Task Force (CAMTF), lead by the US Army Infantry School, Ft. Benning GA, is developing the requirements (design and locations) for future urban operations facilities, including instrumentation.
- The Air Force and Marine Corps are building large-scale ground targetry (cities and industrial complexes) for aviation experiments and training.
- The Marine Corps is leasing civilian and commercial large-scale urban sites for experimentation and training of combined arms operations.
- The Army is leading the development of new instrumentation for ground operations. New formal requirements are emerging from experiments and demonstrations conducted to date.
- The Marine Corps, in pursuit of larger-scale facilities for both ground and air activities, is forgoing an aggressive pursuit of instrumentation, relying on traditional observer-controller concepts. Air instrumentation, particularly those un-

der development with accurate, multi-functional capabilities, could be directly integrated with ground instrumentation to support urban air operations.

A recent General Accounting Office report[2] highlighted several problems not yet addressed:

- A lack of joint and interoperable urban training facilities.
- A lack of coordination between Services in the design and development of new sites.
- No joint training requirements to drive the facility and instrumentation requirements.
- No process for information gathering and dissemination relative to urban facilities.

Instrumentation of urban training facilities of more than $3 million in any fiscal year, or more than $5 million total must, in accordance with OSD policy, be roadmapped in the Joint Test and Training Range Roadmap (JTTRR). The Training Instrumentation Resource Investment Committee (TIRIC) is preparing the initial urban operations facility roadmap, to be subsequently provided to the Defense Test and Training Steering Group (DTTSG) for approval as the initial Urban Training Facilities Category of the JTTRR. Serving as the baseline roadmap, all future facility investments exceeding the previously mentioned thresholds will have to be approved by the DTTSG, to be included in future annual updates of the JTTRR. DTTSG approval will be predicated (possibly withheld) on issues such as redundancy, currency of design with respect to joint and interoperability requirements. The Joint Staff is conducting a Joint Urban Training Study that should provide insight to the specific facility requirements for interoperability and joint training. These factors, when approved by the Joint Staff, and alternative sources of adequate facilities will also serve the DTTSG roadmap decision process.

Additionally, OSD Personnel and Readiness should mature the urban operations facility elements within a web network to be determined in the near future. Thus, robust, detailed information on each site (maintained by each site) will serve a wide variety of DoD users from training providers to investment decision makers. The TIRIC will provide assurance of the comprehensiveness and currency of the training information provided through this network.

---

2 US General Accounting Office, *Military Capabilities: Focused Attention Needed to Prepare US Forces for Combat In Urban Areas*, GAO/NSIAD-00-63N1, Report to Congressional Committees, February 2000.

Directions

Programming for interoperability and joint training facilities is not being included in Service Program Objective Memoranda (POMs). Urban facilities and instrumentation are not the only ones being shortchanged when it comes to funding and support. The Services program and expend limited resources on core training requirements first. This very constrained level of funding has lead to a recognized deterioration of all the Services' Major Training Centers, let alone the satisfaction of interoperability and joint training requirements. Occasionally, interoperability training requirements lead to unique systems to bridge the boundaries between Service core training systems. Yet there is no joint funding for the development of these capabilities, let alone their procurement. This is going to complicate and delay the establishment of urban training facilities that lend themselves to joint and interoperability training.

A joint and interoperability training development fund similar to the Central Test and Evaluation Investment Program (CTEIP) should be established to provide for the research and development (R&D) of systems to satisfy joint and interoperability requirements and to foster joint facilities and instrumentation programs. This fund should also include procurement funding (unlike CTEIP) to serve as incentive funding for Services to field systems that link their facilities with the training centers of other Services to foster interoperability and joint training. While not limited to urban facilities and instrumentation, it should be robustly funded to adequately address simultaneously urban requirements as well as long-standing requirements for other related areas (such as close air support and combat search and rescue). (A high priority example of an application of this fund would be to develop the interfaces and necessary modifications for air instrumentation to not only integrate with maneuver ground instrumentation, but also to define and incorporate elements of functionality needed for urban operations when this instrumentation is used in conjunction with (overlaying) urban training facilities.)

H. Policy and Legality

Key Challenges

New doctrinal and conceptual approaches as well as emerging technologies are beginning to give cause for optimism that dramatic improvements might be realized regarding current capabilities to operate within urban areas. Fueling these possibilities are new concepts and revolutionary technologies in areas such as C4[3], ISR, robotics, precision minimal collateral damage weapons, hunter-killer UAVs, and non-lethal effects. As separate entities, it is unlikely that any will provide a silver bullet to adequately address the unique challenges and complexities of urban conflict. But combined they represent revolutionary potential. Yet many possible remedies to gaps in urban capabilities have both legal and policy implications which, if left unresolved, may lead to missed oppor-

---

3 Command, control, communications, and computers.

tunities. The discussion that follows relates to non-lethal effects, and serves as a template for other areas as well, such as robotic weapon systems, information operations, or certain pre-conflict activities.

Non-lethal technologies have the potential to not only improve but perhaps revolutionize abilities to operate more efficiently and productively in complex urban environments. They not only enhance current lethal capabilities but also provide commanders at all levels with alternatives for addressing threats while simultaneously limiting both collateral damage and noncombatant casualties. As such, they provide opportunities to modify and create new operational concepts, which, in turn, affect all elements of DOTMLPF. However, to realize this potential there are a number of policy issues that must be resolved such as legality, weapon posture and employment, multinational operations, intelligence requirements, sensitive technologies, terminology, public awareness, rules of engagement (ROE), and operational and strategic application.

To varying degrees, these are being addressed by the Joint Non-Lethal Weapons Directorate and OSD. The most aggressive activity is in the areas of Legal, ROE, Non-Lethal Weapons Posture and Employment, and Multinational Operations. The areas that appear to be the most difficult, and in need of enhanced focus and increased levels of effort, appear to be Legality, Terminology, Public Awareness, ROE, and Operational and Strategic Application.

Directions

Legality is the central issue concerning non-lethal effects, and it is compounded by a number of contributing issues, some of which are described in the following.

The term "non-lethal" is a misnomer as many of the technologies can in fact be lethal under certain circumstances. Therefore, using this term may create unrealistic expectations leading to a number of dilemmas regarding policy, legality, and public awareness. However, JFCs should be aware that DoD Directive 3000.3, *Policy for Non-Lethal Weapons*, states that non-lethal weapons shall not be required to have a zero probability of producing fatalities or permanent injuries. Additionally, it further states that non-lethal weapons may be used in conjunction with lethal systems to enhance lethal systems' effectiveness and efficiency in military operations.

While development and use of non-lethal technologies remain contentious legal and policy issues, new concepts of employment and technological breakthroughs are emerging which can significantly improve, if not revolutionize, current capabilities regarding friendly and non-combatant casualties and collateral damage. Despite these possibilities, there is no formal method to plan and execute an active media campaign to explain to both a domestic and global audience the scientific and moral aspects concerning the use of these systems. While some effects may not be mature enough to adequately explain, a strategy should be developed now to educate the public for those that are, and it should

address the issue in developmental phases as well as planning and employment phases. Without such a strategy to inform public opinion regarding the use of such systems, their revolutionary potential for urban operations may never be realized.

Like all ROE, non-lethal ROE are extremely important and can potentially lead to serious operational problems. Although they do not write ROE, commanders must endeavor to ensure that ROE are simple and clearly understood. They should also cover both lethal and non-lethal weapons, and allow for a logical escalation from non-lethal to lethal means if circumstances dictate. They also should authorize the user to use non-lethal force when authorized to use lethal force, and allow release authority for non-lethal weapons at the level of command where the organic weapons are located. For example, company commanders should be authorized to employ weapons organic to their unit, and individuals must be authorized to use any weapon with which they are equipped.

Non-lethal systems are currently focused on tactical applications for ground force use. Much more needs to be done to address operational and strategic applications. While Non-lethal Core Capabilities are discussed primarily in terms of counter-personnel and counter-materiel, the directorate has recently begun to address strategic and national issues. Focusing on identification and examination of strategic applications, the aim is to concentrate on potential influence or impact rather than on the mechanics of employment. Counter-personnel, counter-material, and the recently added core capability of counter-capability. Counter-capability focuses on two functional areas of (1) neutralization of systems and facilities, and (2) denying the use of WMD, each having potential operational and strategic impact. The Joint NLW Directorate (JNLWD) is not authorized to address command and control warfare (C2W) within its mandate.

While many dismiss currently fielded counter-personnel systems as "beneath strategic" since most of their applications are seen as tactical in nature, their interpretation reflects only the physical effects and neglects the strategic impact of using the systems. Furthermore, it fails to consider the potential for more capable technologies to be realized in the future. The strategic impact is embodied in the use of non-lethal systems themselves as it allows and facilitates the seizure of the moral "high ground" and influences the media and targets of the information campaign. While important in all operations, it is especially important in the case of peacekeeping operations where the strategic objective is typically winning the hearts and minds of the people.

Counter-materiel systems appear to present more easily identified "strategic applications." For example, one area offering promise is the use of counter-material non-lethal effects as a precursor to a lethal attack. Referred to as a "pre-lethal" attack, such an attack might be the non-lethal disabling of an enemy's integrated air defense system, which would make the enemy substantially more vulnerable to follow-on combat operations. In this example, the line between operational and strategic could easily be blurred,

but the potential operational and strategic results, especially if the enemy's will to fight is impacted, are undeniable.

Other counter-materiel examples also have potential operational and strategic impact since they relate to concerns about collateral damage. For example, by using non-lethal weapons, military objectives may be accomplished while limiting the level of damage to the enemy's national infrastructure, thus avoiding the need to spend large amounts of time and money to rebuild what would have been destroyed if traditional weapons were used. In another example, instead of destroying power plants and transmission stations, non-lethal effects could be used to interrupt power supplies thereby limiting second- and third-order effects. Or, instead of destroying a bridge to deny access to an area, reversible anti-traction materials or rigid foams might be used.

With regard to collateral damage issues, current capabilities to take out a command post near a religious structure would likely require the use of a precision-guided bomb, which would probably result in collateral damage to the religious structure. In the future, it may be possible to neutralize the command post with an EMP (electro-magnetic pulse) device delivered by a cruise missile. This approach would not damage the religious structure and would therefore allow for the engagement of targets that would previously have been restricted.

In the final area, that regarding WMD, the strategic implications are even more clear. The problem of how to neutralize WMD weapons, production and storage facilities, and delivery means without endangering the surrounding areas could be addressed with non-lethal weapons. A number of different yet promising possibilities include EMP and High Power Microwave as well as rigid foams and other sealants.

I. Coalition, Interagency, and NGOs

Key Challenges

Since DESERT STORM, every contingency in which the United States committed military force has had an urban aspect to it where the noncombatant populace, multinational military and civilian partners, interagency representatives, NGOs, and private volunteer organizations (PVOs) are compressed into the urban "battlespace." Further, political constraints on the military in contingencies that are short of major-theater war serve to complicate operations. Military forces find themselves involved in unfamiliar, nontraditional roles. To be successful in the strategic sense, the activities of militaries and other disparate organizations need to be well coordinated.

Today's civilian-military relationship is rooted in the National Security Act of 1947. The structure of the US interagency has served the nation well in peace and times of conflict, including Korea, Vietnam, and DESERT STORM. When the use of force was implemented, the military instrument of power was usually in the lead and other instruments

were in more of a supportive role. Since the end of the Cold War, however, the United States has become increasingly involved with multinational partners in operations short of major-theater war. In these contingencies, the military may be the lead instrument initially, but it soon transitions to a supportive role while a diplomatic solution is sought. Unlike traditional operations, the military now finds itself involved in activities such as humanitarian efforts, facility and structure repair, and law-enforcement training. Instead of employing national instruments of power sequentially, we now employ them simultaneously. Required coordination within the interagency and between multinational partners is always a great challenge, but particularly difficult in organizations that are "stove-piped." Communication and coordination between our military, the interagency, multinational partners and NGOs/PVOs is limited by lack of organizational cross-representation, contingency planning, exercise participation, and education.

The USJFCOM is responsible for leading the transformation of US military joint capabilities. USJFCOM activities include interagency coordination, instruction to the Combatant Commands, and the development of concepts, doctrine, and experimentation on the multinational level.

In 2000, USJFCOM participated in an OSD project titled LINCOLNIA. This event incorporated experimentation and exercise activities at the strategic, operational, and tactical levels—all within a common urban scenario. It was unique in that it brought interagency planners, an operational joint staff, and experimenting tactical units together, and set the stage for a series of similar follow-on events. USJFCOM additionally created a Multinational Concept Development and Experimentation Cell and has planned a series of Joint Futures Labs (JFLs) and Limited Objective Experiments (LOEs) with multinational partners to explore information sharing and collaboration during Rapid Decisive Operations (RDO) with coalition partners.

The National Defense University (NDU) sponsors recurring seminars and conferences such as "Civil Dimensions of Military Operations" (1998) and "Beyond Jointness" (1999) that examine the civil-military dimensions of peace operations. In particular, the participants focused on civil-military unity of effort, education of military commanders about the challenges of operating with NGOs (and, more generally, with civilians about military activities), and the availability of resources to meet special demands. NDU has also teamed with the State Department in a SHARED DATAproject. This is an effort aimed at developing an internet-based means to provide for nteragency-shared data, a "common view," and collaboration and planning tools. The intent is to use current technology to upgrade traditional means and processes of communication and planning.

Presidential Decision Directive 56, Managing Complex Contingency Operations, was signed in May 1997 and mandated a process for political-military planning for complex contingencies within the interagency. NDU sponsors annual training of interagency members on this process.

Multinational efforts, such as the US, French, German, UK "Coalition Military Operations" study and the US-sponsored Coalition Headquarters Design conference examined how allies and future coalition partners can co-evolve efforts toward greater interoperability including doctrine development, training, and procurement.

Directions

To address multinational and interagency interoperability shortfalls, it is necessary to greatly expand our capabilities to form political-military plans and coordinate civil-military operations. In 1986 Congress recognized that the military needed to make fundamental changes in order to give the appropriate attention to joint issues. The changes mandated by the Goldwater-Nichols Act included organizational, process, training, and education. Now is the time to mandate similar changes to enhance civil-military-multinational capabilities. Instead of waiting for Congress to act, the President could issue a National Security Presidential Directive (NSPD) that mandates the following.

- Establish positions and billets in the military and other agencies to provide an integrated and continued presence of interagency-experienced advisors to the military, and military Civil Affairs expertise to the interagency. Also, provide greater military and interagency liaison to international and regional organizations (e.g., United Nations, European Union, Organization for Security and Cooperation in Europe, Organization of American States, Association of South-East Asian Nations).

- Conduct a study to determine the correct balance between the Active and Reserve components of the military civil affairs population (currently 97% reside in the Reserves), and transfer enough into the Active component in order to provide representation to the international and regional organizations mentioned in the first item.

- Provide experienced interagency, international organization, and NGO personnel to PME institutions for the purpose of enhancing the education of interagency, US, and foreign military students.

- Establish a NDU-sponsored recurring program (symposia, conferences, exercises) for civil-military cooperation and understanding, with participation of international organizations, NGOs, the interagency, and the military.

- Integrate the interagency (strategic-level political-military planning), international organizations, and NGOs into Combatant Command exercises.

- Develop an internet-based means to provide data fusion and collaborative and decision-making tools for interagency, international organizations, and NGO/PVO planning and execution for crisis contingencies.

- Provide the resources and direction to USJFCOM to plan, organize, and conduct experiments that include the interagency, international organizations and NGOs, allies, and multinational partners which includes reporting of lessons learned to the Joint Staff and Combatant Commands.

- Establish a core group within the National Security Council and interagency of political-military planners that constitute the strategic-level mechanism for contingency planning and participation in USJFCOM experimentation and Combatant Command multinational exercises.

Today, contingencies are characterized by policies restricting use of force because of concerns about noncombatant casualties and collateral damage. The necessity of dealing with the interagency representatives, as well as international organizations, NGOs, and multinational agencies calls for new approaches to urban operations that current organization, training, and education programs do not address. The above recommendations would greatly enhance our current capability, and set the right example for our allies to do the same.

J. Concept Development and Experimentation

This section describes the actions and processes needed to develop and experiment on new concepts and capabilities for urban operations.

Key Challenges

The Joint Force Commander (JFC) will not—and cannot—get major new urban operations capabilities in the next few years. The low investments in the 1990s—in the areas of concept development, organization, doctrine, and materiel—preclude early availability of new operational concepts based on new enabling capabilities. There are few "low hanging fruit" with major payoffs to pick and give to the JFC.

Other sections of this document describe a wide range of benefits potentially available to a future JFC engaged in an urban operation. But to get these benefits requires a program of exploration akin to the Lewis and Clark Expedition. From 1803–1805 Lewis and Clark explored western North America, sorting out the reality from the myths, and thereby providing a basis for understanding how the United States could best use the potential opportunities in this new territory.

Determining how to best use the potential opportunities for urban operations will require years of exploration. We need to explore the technical feasibility of new sensors, platforms, robotics, and non-lethal weapons, by leveraging existing R&D programs. We need new organizational arrangements (expanding on existing *ad hoc* arrangements) to gather, fuse, and make available the data that would enable joint fused information. We need to improve urban operations models and simulations and analyses, to be able to assess the usefulness (cost, effectiveness, risk) of new capabilities and organizations in

enabling new concepts. Finally, we need to understand the usefulness of new concepts (including the human role) for urban operations through experiments involving the full range of expertise on urban operations (military, civilian, multi-national).

The key to making it possible for a future JFC to have improved capabilities for urban operations is to build a plan—now—that will put in place multi-year programs of exploration. Many of the types of explorations needed to get new capabilities for urban operations are ongoing today, but most are not explicitly addressing urban operations.

The technical community within DoD has a diverse set of ongoing R&D programs. New sensors and platforms go from satellite-based radar, to UAV-based optical and IR (infrared) sensors to unattended ground systems (both fixed and mobile) with electromagnetic and acoustic sensors to swarms of tiny airborne sensors. New non-lethal weapons can target people, equipment, and facilities. Robotics programs include ground, air, and sub-surface mobility. Many of these capabilities could be useful for urban operations. But few of these programs look at how the new technologies could work in an urban environment.

The intelligence and information community has long recognized major imbalances in its programs. For example:

- What is collected (lots) versus what is analyzed (little).
- Demands by joint commanders for its systems (high) vs. density of its assets (low).
- "Individual-INT" databases (all) vs. fused "all-INT" classified and unclassified data bases (few).[4]
- Individual service databases (many) vs. joint fused databases (virtually none).

New concepts for urban operations will be more information intensive than operations in other environments. So the absence of joint fused data bases for the JFC—in theater or available by reach-back—will be a greater impediment to improving operations in urban areas than in other environments.

The DoD analytical community consists of many institutions that develop models and simulations and analyze the cost, effectiveness, and risk of new technologies and organizations in different scenarios. Each Service has Battle Laboratories focused on diverse Service issues. OSD has analytical organizations in the Office of Net Assessment and the Office of Program Analysis & Evaluation that address air, land, sea, special op-

---

4 That is, HUMINT, COMINT, SIGINT, MASINT, etc.

erations forces, and space forces. Defense agencies do analysis of a range of issues (e.g., the Defense Threat Reduction Agency). DoD funds many Federally Funded Research and Development Centers (FFRDCs) with their own centers of excellence (e.g., the RAND Arroyo Center for the Army) focused on different Service and Joint issues. But for urban operations, no Battle Laboratory exists, no OSD or Defense agency office exists, and no FFRDC Center of Excellence exists.

In 1998 DoD directed USJFCOM (then called Atlantic Command) to use joint experiments to search for new more effective operational concepts. Since then, major joint experiments were used by the Joint Advanced Warfighting Program at the Institute for Defense Analyses (in JOINT EXPERIMENT 99-01) and by USJFCOM (in ATTACK OPERATIONS 2000) to explore a new concept for attacking critical time-sensitive targets. The focus of these human-in-the-loop experiments was on a Red TBM (Theater Ballistic Missile) force. In both experiments, urban areas were simply treated as sanctuaries for Red TBM forces. (Although one Blue Team, in an *ad hoc* scenario, did explore how well a smart weapon, with a smart on-board sensor, could attack transporter-erector-launchers (TELs) in an urban area.) The recently completed USJFCOM joint experiment, UNIFIED VISION 01, involved no urban operations.

In sum, lots of exploration is going on today by the technical community, by the intelligence/information community, by the analytical communities inside and outside the Services, by USJFCOM in joint experimentation. but few if any are focused on urban operations, and when urban is included, it is only as an add-on.

Directions

Several actions are needed now to put in place the multi-year explorations that could lead to new capabilities for urban operations for a JFC.

- **Plan to explore technical feasibility in complex terrains.** Ongoing technology explorations of new sensors, platforms, non-lethal and robotic systems should be tasked to address how to make them effective when used in an urban operation. A new Special Assistant to the Under Secretary of Defense for Acquisition, Technology, and Logistics should be established, with responsibility for encouraging ongoing technology development programs to address their use in complex environments (i.e., urban, forested, and mountainous areas).

- **Explore organizational arrangements for information.** The intelligence and information community should develop a plan for the joint fused data needed for an urban operation, and should test the plan by developing that data for an exemplar urban area. Additionally, a National Fusion Center should be created to provide the JFC with the fused joint data needed, including data needed for urban operations.

- **Explore the usefulness of new technologies & organizations.** OSD should ensure that new and upgraded DoD models and simulations, intended as DoD or Service standards, can provide their intended results in contingencies involving urban operations. Organizationally, a standing Center of Excellence for Urban Operations should be established, and a standing office for urban operations should be established within OSD (Program Analysis and Evaluation).

- **Explore the usefulness of new operational concepts.** Urban operations should be included in more experiments, and the DoD-wide expertise in urban operations should be fully involved in the planning, execution, and analysis of any USJFCOM experiment involving urban operations, including the red teaming. In addition, USJFCOM J9 should establish an office responsible for assuring that USJFCOM experiments reflect the expertise in urban operations that exists within DoD, other US sources, and allied organizations.

K. Modeling and Simulation

Key Challenges

Challenges facing those who want to improve the MOUT Modeling and Simulation (M&S) capability cover a full gamut, addressing not only the needs of concept development activities but also training, acquisition, planning, and mission rehearsal.

Methodologies involving M&S tools that are appropriate in addressing MOUT issues owe their usefulnessto users being able to phrase the right question and to define appropriate measures. Only then can one say whether a model or simulation is appropriate at all, whether it is the right one to use, or whether some enhancement or modification may be required. That is true whether the application sought is in the realm of analysis, training, planning, or mission rehearsal.

Unfortunately, the ability to define a simulation need accurately and to clearly formulate a question the answer to which is sought through M&S is an art not mastered by many in general terms. In the MOUT arena, the challenge is particularly acute. This is true despite the notoriety urban operations have had recently, and the appreciation that they present a likely venue for military operations in the foreseeable future. Still, they are not widely understood in terms of scope, complexity, and operational challenge. Some part of this problem will reach resolution as progress in improving urban capabilities is made.

Program managers and trainers, however, need to understand that M&S are not built in a day. The age-old problem of anticipating the M&S need sufficiently in advance of the time it will be required is more of a general military cultural problem than it is an appreciation of the situation. Few managers understand that they cannot have the M&S they

want because their predecessors failed to invest in upgrade and enhancement. Fewer still are willing to invest in M&S enhancement on behalf of their successors.

All of this is quite apart from the problem of understanding what technical changes are needed in models themselves because of the requirement to address MOUT. As a result, with the exception of the Joint Conflict and Tactical Simulation (JCATS), few models have any MOUT representational capability, and the new, large DoD-sponsored models, such as the Joint Simulation and Integrated Modeling System (JSIMS) and the Joint Warfare Simulation (JWARS), have no MOUT capability at all.

The technical challenges fall generally into five areas:

- Digitization of urban terrain and availability of the digitized product.
- The accurate representation of the urban environment, to include interiors of buildings and their external relationships, both subterranean and above ground.
- The simulation of urban infrastructure.
- The data which represent the various dynamics of force deployment and human behavior.
- The "space-to-face" problem caused by the wide range of both data and knowledge demanded by different users.

The terrain digitization issue is well known, as it exists for all areas of the world's surface but is particularly acute for urban areas. Representation of structural complexity and detail is problematic because of the problem of acquiring the data appropriate to the specific area to be modeled and to the lack of skill and funding required to create the appropriate representational computer code. This is particularly true of urban infrastructure representation. The data problem is purely an extension of a general problem that exists for all modeling, but is particularly intractable for urban operations. We have not been adept at collecting such data in the past, and we cannot march troops into an urban area, fire live ammunition at them and collect data, given that the urban area had been properly instrumented for data collection. The "space-to-face" problem occurs, for example, when one person wants to view the urban area from afar, appreciating the general layout of an urban area for purposes of operational-level planning and maneuvering; while others would like to know the type of door-closing device on the third door from the left on the West Side of a specific building on King Street in Alexandria, Virginia.

The MOUT ACTD has been focusing on technologies, the manifestations of which could be placed in the hands of soldiers and Marines for an evaluation period at the end of the program. It also provided funding for, and management of, urban enhancements

made to JCATS. This model had considerable urban representation capability when the program began, and this was improved over the course of time. For example:

- JCATS has been used extensively by the MOUT ACTD, the Army Dismounted Battlespace Battle Lab, and the USMC in their MOUT pursuits. Urban enhancements to JCATS continue.

- At the same time, the Army has initiated a Joint Virtual Battlespace (JVB) program at Ft. Belvoir, Virginia, as part of the Objective Force Task Force effort, and has selected the JCATS model to provide the initial MOUT capability.

- The Army has also established a MOUT study program at TRAC (the US Army Training and Doctrine Command Analysis Center) at Monterey, California, to develop greater understanding of the problems unique to MOUT M&S, and it continues to provide some urban upgrades to models such as Janus and the Soldier Station.

- Future models, such as OneSAF and Combat XXI have planned MOUT capabilities.

- Nevertheless, the only constructive model that has extensive MOUT capability continues to be JCATS, and it has been included in the federated collection of models to provide that capability for the Synthetic Theater Of War (STOW) at the National Simulation Center and other locations.

- Additionally, work is in progress on forming a model federation between JCATS and the Integrated Unit Simulation System (IUSS) to provide greater capability of portraying individual combatant dynamics in the urban environment.

In the area of data collection, the National Imagery and Mapping Agency (NIMA) has programs in place to collect digitized terrain data for areas of the earth's surface. and the National Ground Intelligence Center (NGIC) is in the process of collecting, analyzing, and projecting technical data for possible use in threat representation. While NIMA's efforts are noteworthy, the world is a very large place, and predicting what part of its surface will next need representation is always a challenge. Additionally, the construction of man-made features on the selected surface remains a time-consuming and sometimes frustrating prospect. Collecting useable data attendant to urban operations during troop exercises at various MOUT facilities is under study by both the Army and the USMC.

Directions

- First, efforts should be intensified at all levels, from establishing terrain databases for areas around the world to assembling data for specific urban areas.

- Next, draft and promote a plan, based on a solid data needs assessment, to appropriately instrument MOUT sites and associated areas so that individual combatant human response and small unit dynamics data may be collected and made available.

- Funds should be provided for the continued maintenance and enhancement of urban representation in existing models, based on sound study results and user requirements. This should occur concurrently with the planned development of MOUT capabilities in the emerging set of approved future models—stop trying to invent new models from scratch. It is extremely expensive and rarely results in anything available and useable by the community that needs it. Build on what we know and let capabilities evolve. "Not invented here" is not a valid excuse. Define and adopt more realistic approaches to the verification and validation of these models to facilitate their accreditation for specific purposes.

- The balance between control, destruction, maintenance, and repair of urban infrastructure will be vital to successful future urban operations. Current models do not represent, for example, urban transportation, electrical, health, or public communications capabilities to any appreciable degree. And there should be a M&S link represented between military operations and the degree to which that infrastructure is affected by, or affects, military presence and the dynamics of conflict.

- Finally, education is needed for managers, trainers and analysts. This is a two-part need. The first part is general in that it involves generating awareness that model development takes time and funding, and that the potential users need to be part of the process. The second part is more specific and involves the education of managers, trainers, and analysts in the technical details of modeling urban environments and the dynamics of confrontation therein.

VII. Implementing the Roadmap

A. Introduction

Prior chapters identified programs to explore new technologies, and activities to explore new thinking, that could lead to new capabilities for future JFCs in urban contingencies. This chapter describes steps that would help implement these programs and activities.

As discussed previously, the challenges to significantly improving urban capabilities, though daunting, are potentially solvable. New technologies for sensors, lethal and non-lethal weapons, platforms, and robotics offer promise to overcome current limitations. New thinking about doctrine, operations, training, policy, and operational concepts can show how to exploit these technologies to improve the JFC's ability to "understand," "shape," and "engage with precision." In time these efforts can lead to the sets of DOTMLPF that are key to new capabilities.

But implementation of the programs and activities that are critical to the new capabilities cannot be taken for granted. There was little consensus in the 1990s to improve capabilities for urban operations, despite the evident dangers and the emerging technological opportunities. The very decision to have the *FY-2001 Defense Planning Guidance* direct a study to create a roadmap for urban operations reflects the lack of consensus then—and the likely difficulty today—to implement the needed changes. So how to increase the likelihood of implementing the changes identified in the Roadmap needs to be addressed.

B. Alternative Approaches to Implementation

Implementation of the Roadmap recommendations for new programs and activities could be driven in several ways, including solution-, leadership-, staff-, and externally-driven approaches.

- **A solution-driven approach** builds on the assumption that what has been missing until now has been the "solution"—namely, a clear, compelling, and comprehensive plan, with a coherent set of recommendations for how to improve capabilities for urban operations. The premise in this case would be that the Roadmap now provides this, and so the Roadmap recommendations will be implemented.
- **A leadership-driven approach** builds on exposing the senior DoD leaders (e.g., the Secretary and the Chairman) to the need for improved capabilities and to the ways that implementing the Roadmap recommendations would meet this need—and getting their enthusiastic commitment and personal attention to doing so. The premise is that a "solution" alone will not lead to implementation

unless the senior leaders direct the Services and Defense Agencies to implement the recommendations—and then follow up.

- **A staff-driven approach** builds on setting up entities within OSD, Defense Agencies, the Services, and the Joint Staff that are focused on urban operations issues. These entities would encourage DoD exploratory programs and activities to give a higher priority to exploring new capabilities for urban operations. They would use the results of these explorations to identify the DOTMLPF sets that promise major new capabilities. The premise is that a "solution" alone will not lead to implementation unless staff-driven activities build up support over time for implementing each recommendation.
- **An externally-driven approach** would build on a major failure of US forces while conducting an urban operation. The premise is that Congress would conduct a review of the causes of the failure and would then legislate the "solution"—perhaps drawing on recommendations in the Roadmap.

The approach to implementation adopted for this Roadmap focuses on the steps for a **staff-driven approach**. Support of the senior leaders is important, but implementation of the Roadmap recommendations should not depend on their personal commitment. Nor should implementation depend on the belief that all that's been missing is a Roadmap. And implementation should not wait for an operational failure—it should preempt it.

C. Steps to Improve Implementation Prospects

This section describes specific steps for a staff-driven approach that would significantly increase the prospects of realizing the Roadmap recommendations. These steps fall into three categories:

- Steps to increase DoD organizational oversight and attention to the issues posed by future urban contingencies.
- Steps to increase DoD priorities and sense of urgency for urban operations issues in DoD exploratory activities (e.g., in the organizations funded to do intelligence, concept development and experimentation, technology development and demonstration).
- Steps to create a new organization to fund and field the key enabling capabilities identified in the exploratory activities.
- Steps to develop relations with organizations outside DoD, including interagency, e.g., Department of Homeland Defense, and multinational, e.g., NATO.

The following sections discuss each category of steps.

1. Steps to Increase DoD Organizational Oversight and Attention

The last Defense Science Board to focus on urban operations (in 1994) noted that "there is no single advocate or champion for military operations in built up areas within DoD" and recommended assigning that responsibility to a Combatant Commander. Several times last year the issue of an organizational focus within DoD has been raised to senior levels in DoD.

A GAO report, *Focused Attention Needed to Prepare US Forces for Combat in Urban Areas* (February 2000), recommended that **Secretary of Defense designate a focal point** for urban operations. The focal point's tasks would be to:

- develop an overarching strategy for improving US capabilities for urban operations;
- identify shortfalls in doctrine, training, and equipment;
- propose and prioritize needed investments; and
- coordinate efforts among the Services and the Joint Staff. As of July 2002, the Secretary of Defense has yet to formally designate such a focal point.

The report of the House Armed Services Committee on HR 4205 (May 2000) directed **the Secretary of Defense designate an Executive Agent** for urban operations. The Executive Agent was to develop and coordinate a master plan for a DoD-wide strategy, with milestones, for improving Service and joint capabilities for military operations in urban environments. As of July 2002, the Secretary of Defense has yet to designate the Executive Agent.

A memorandum (August 2000) from the Deputy Under Secretary of Defense for Advanced Systems and Concepts to the Joint Staff Director for Force Structure, Resources and Assessment (DJ8) noted that the pressing need in addressing problems in urban operations was to define and prioritize joint requirements. He recommended that the **DJ8 create a small organization** of 8 to 10 full-time people to focus on enabling development of new options for decision. The DJ8 proposed, instead, integrating the existing requirements generation system, the new Joint Warfighting Capabilities Assessment (JWCA) organization, and the evolving role of the Joint Requirements Oversight Council (JROC).

A briefing (January 2001) to the Joint Requirements Board (JRB), by the Dominant Maneuver JWCA Team, addressed organizational means to integrate the various DoD efforts to identify joint requirements in urban operations, as well as develop alternative solutions. The briefing offered the JRB **four new organizational arrangements:**

- establishing a Joint Office, Organization, or Agency;
- establishing a Major Force Program Office;

- designating a Service Chief as DoD Executive Agent; and
- designating USJFCOM as DoD Executive Agent.

It also offered a study group option, which would leverage and focus existing organizations and processes by establishing a Special Study Group for Joint Urban Operations for the rest of calendar 2001. **The Study Group option was adopted by the JRB.**

Collectively, the initiatives over the past year identified all the impediments to improving urban operations capabilities, namely:

- No DoD document describing the need for new capabilities.
- No DoD plan for programs and activities to get these capabilities.
- No organization within DoD to provide a focus for urban operations.

With the publication of the DoD Roadmap, there is now a document describing the need for new capabilities in urban contingencies, and an initial plan for programs and activities that would lead to major improvements in capabilities. But what are still needed are the organizational focuses for urban operations. These organizational focuses should be created within OSD, the Services, the Combatant Command headquarters, and the Joint Staff, since all play a role in getting the joint capabilities needed. The organizational steps proposed below would establish the organizational focuses needed.

Step 1. The Secretary of Defense establish a DoD Executive Agent for Urban Operations.

The Executive Agent would be the DoD-wide focal point for urban operations described above. The establishment of this position would fulfill the commitment expressed by the Deputy Secretary of Defense in his reply to the House Armed Services Committee. Recommendations identifying who the Executive Agent should be, and specific responsibilities (beyond producing the *DoD Master Plan for Improving Capabilities for Urban Operations* and overseeing its implementation) would be made by the Special Study Group for Urban Operations convened by the Joint Staff to address these issues.

Step 2. DJ8 establish a standing lead Joint Staff office for urban operations.

This office would work with Services and Defense Agencies, and would serve as the focal point for Combatant Command and Service requirements. It would build consensus through the JROC–JWCA process to influence the Program Objective Memoranda (POMs). Key tasks would be to identify and develop (or task development of) joint mission capstone requirements, define required system inter-operabilities, and assist in the evolution of the urban operations plan.

Step 3. OSD Director, Program Analysis and Evaluation, establish a standing urban operations team.

This team would assess current capabilities and how they would change over the Future

Year Defense Plan (FYDP), and would assist in the evolution of the urban operations plan. During the POM review it would review Service POMs, and identify issues for decision and develop alternatives. It would work with the Defense Modeling and Simulation Office to develop good models and simulations for urban operations.

Step 4. The Services establish a standing lead office for urban operations.

These offices would help prepare the Service POMS, and would identify critical Service programs and activities to pursue.

Step 5. The Combatant Commanders establish a point of contact for urban matters.

These points of contact would take the lead in reviewing the adequacy of Service programs and activities intended to improve joint capabilities for urban operations.

Step 6. ASD (Policy) set up a DASD-level Urban Operations Policy and Coordination Group.

This DoD-wide group would identify policy and legal issues (e.g., associated with directed-energy weapons and non-lethal agents), to be addressed. It would coordinate efforts among DoD, inter-agency, NGO, and allied forces toward better urban operations capabilities. This group would also respond to the interests expressed by Congress.

Step 7. USD (Acquisition, Technology, and Logistics (AT&L)) appoint a Special Assistant for Capabilities in Complex Terrain.

This Special Assistant would encourage ongoing development programs to attend to the needs of military operations in complex terrain (e.g., the natural environment in mountains, forests and jungles), and the built-up environment (and civilians present) in urban areas. The Special Assistant would advise USD (AT&L) and the Defense Resources Board on how to leverage ongoing developments so that they would offer major improvements to operations in complex terrains.

The seven organizational steps described above would meet the objectives of all the proposals made in the last two years on getting a DoD focus for urban operations.

2. Steps to Increase DoD Priority and Sense of Urgency

Organizations within DoD and the Intelligence Community get funded each year to broadly explore new capabilities. These explorations involve organizations doing intelligence, concept development and experimentation, and technology development and demonstration. This section addresses steps that are critical to getting a higher priority – and so a fairer and larger share of organizational resources—to exploring better capabilities for urban contingencies.

Intelligence

Step 1. The Defense Intelligence Urban Working Group to expand the Intelligence Community exploration of the data and models needed for urban contingencies.

This would include expanding the ongoing experimentation on knowledge management, the exploitation of theater imagery, and the efforts to provide a crisis surge-capability for mapping in urban areas. (See Chapter IV, Section 7, of this volume for more details.)

Concept Development and Experimentation

Step 2. The Executive Agent for Joint Urban Operations to set up an Urban Operations Center of Excellence.

The Center would be the focus for studies and seminars, concept development and experimentation, adaptive Red Teaming, developing new metrics, and identifying sets of DOTMLPF that could provide major new capabilities. This Center should be about the same size as an Air Force Battle Lab (about 30 people) and should have a mix of civilians and active duty personnel, either detailed or on joint assignment.

Step 3. Joint Forces Command to include urban operations in its program of concept development and joint experimentation.

USJFCOM's major experiments in FY01 and 02 offered little exploration of urban operations (since they are mostly field demonstrations set in the near term). The experiments planned for FY03 and 04 are intended for discovery in the period beyond 2010 and so could help explore new urban concepts and capabilities consistent with the USJFCOM focus on Rapid Decisive Operations (RDO); for example:

- This could be the pre-emptive defense of a friendly urban area to prevent its capture;
- the rapid neutralization of a WMD site in an enemy urban area to prevent WMD use; or
- the prompt isolation of an enemy city to prevent re-enforcements from coming in and/or WMD and theater ballistic missiles from leaving, or the swift neutralization of a hostile group seeking refuge in a city.

Step 4. Combatant Commands and Services to include urban contingencies in their concept development and experimentation.

This should include expanding training exercises so that they address issues in urban contingencies.

Technology Development and Demonstration

Step 5. DARPA and Service Laboratories to create an office or program for urban operations.

The focus would be on exploring how add-on technologies to existing and new development programs could significantly improve urban operations capabilities.

Step 6. OSD and the Services to fund Advanced Concept Technology Demonstrations (ACTDs) and Advanced Technology Demonstrations (ATDs) focused on urban operations.

These should seek new operational-level joint capabilities for the Understand and Shape components that would be useful in urban operations conducted by a coalition.

3. Steps to Create a New Organization to Fund Key Enabling Capabilities

Funding will be needed for the key enablers, funding for expanded or new development programs and, eventually, funding for new acquisitions, e.g., new sensors and communication systems, new air and ground robotic systems.

But in most cases, the enablers in the Roadmap are identified as candidates for further exploration and not for immediate engineering development and acquisition. Thus, no major near-term *acquisition* funding is required. However, to ensure that developmental funding will be directed to improving urban capabilities, dedicated funds are needed specifically for that purpose. The natural office to oversee the expenditure of such funds, and to be an advocate for these capabilities, would be that of the Executive Agent or an organization similar to the Joint Theater Air and Missile Defense Organization.

After the exploration of new technologies and the new thinking on urban operations issues has permitted identifying key enablers and sets of DOTMLPF that should be fielded, acquisition funding would be needed to make this happen. This could be done either with *centralized funding* or *collaborative funding*.

Centralized Funding. This would not be the first time that DoD faced the issue of centralized funding for a specific problem area. President Reagan set up a separate agency for ballistic missile defense, with a several billion dollar annual budget. President Clinton set up a separate office in OSD to fund biological defense measures, with a $100 million annual budget. Similarly, in a few years, when significant funding would be required for enablers for improving urban operations, a separate agency or office could be used to provide the centralized funding, e.g., that of the Executive Agent.

Collaborative Funding Frequently, DoD has given to a specific problem area the challenge of competing with all other programs for funding. The likelihood of getting funding would depend on several considerations:

- In some situations, a key enabler could be achievable by a relatively low-cost upgrade to an on-going development program. In this case, the likelihood of implementation would depend less on the fact of (or cost of) the upgrade and much more on whether the development itself has sufficient support for implementation.
- In some situations, a key enabler could require an expensive upgrade or a dedicated new acquisition program. In this case, the likelihood of implementation would depend on the cost, available funding, and on how much the program adds to the overall program for improving urban operations capabilities.

As the new concepts and capabilities become ready for fielding, and the acquisition costs become significant, centralized funding will become essential (again) for all enablers requiring an expensive upgrade or a dedicated new acquisition program.

4. Steps to Develop Relations Outside of DoD

Step 1. Develop a working group on urban operations involving the agencies with responsibilities for Homeland Defense.

This working group should take the lead in identifying the overlap in capabilities needed for urban operations in foreign countries and for Homeland Defense.

Step 2. Sustain the ongoing relationship with NATO's efforts to identify how to improve urban operations.

The NATO current study[1] is pointing towards the same kinds of new operational concepts and capabilities as this Roadmap.

D. Conclusions

Significant improvements to urban capabilities are needed. This Roadmap identifies a number of programs and activities that could provide such improvements. However, the actual implementation of the Roadmap recommendations cannot be taken for granted. A staff-driven approach is an appropriate way to increase the likelihood of implementation of the thrust of Roadmap recommendations, namely,

- to increase DoD organizational oversight and attention to urban issues;
- to increase DoD priority and sense of urgency for the exploration of greatly improved urban capabilities;
- to create a new organization to fund key enabling capabilities; and
- to develop strong interagency relationships, and multilateral relationships (e.g., within NATO) on the issues involved in urban operations.

---

1 The study, *Urban Operations in the Year 2020*, is scheduled to be published in December 2002.

Appendix A.
MOUT Programs and Activities by Principal Sponsor

This appendix presents brief descriptions of the timeline entries displayed in Chapter IV of Volume I. Unlike Chapter IV, which broke out the efforts primarily by the USECT scheme, this list categorizes activities by their primary sponsor. Within each sponsor's section the entries are alphabetized.

The first index, Programs by Organization, lists the programs by organization, then alphabetically by title. The second index, Programs by Title, lists the programs alphabetically by name.

In general, the cutoff date for information is September, 2001.

Programs by Organization

Explanation of Terms Used in This Appendix **12**

US Air Force **13**

Aerospace Operations in Urban Environments 13
Air Force MOUT Conference 13
Air Force Urban Operations Seminar 13
Combat Missions IRCM (CMIRCM) Prototype System [Proposed] 14
Communication Relay Demonstration 14
Day/Night EO/IR Tracker CM 15
Guardian 15
Global Positioning Satellite Airborne Pseudolite (GAP) 16
Light Weight Modular Support Jammer [Proposed] 16
Low-Cost Persistent Area Dominance Miniature Missile (LOCPAD) 17
Military Intelligence Tactical Element (MITE) 17
Multi-Function Laser Radar 18
Nevada Training Initiative — Urban Target Array 18
Pseudolite Near-Far Receiver 19
Remote Receive Concept (Taclink) [Proposed] 19
SensorCraft Demonstrator 20
Sensor Technology for Difficult Targets Study 21
Small Diameter Bomb 21
Spectral Infrared Remote Imaging Transition Testbed 22
Spectre Kite (Control of Tactical UAV from AFSOC Aircraft) [Proposed] 22
Strix Covert Emplacement Dispenser 23
Surface Extraction and Robust Geolocation for Urban Mapping 23
Tactical UAV Support to Small Scale Contingencies (SSCs) 24
Three-Dimensional Imaging Laser Radar [Proposed] 24
Time Synchronization Among Moving Platforms 25
UAV Delivered Sensors (UDS) 25
UAV to Fighter Imagery Relay (UFIR) 26

UAV Operational Concepts Study [Proposed] 26
Urban and Obscured Target Detection and ID [Proposed] 27
Urban Target Detection and ID Sensor System Concept [Proposed] 28

US Army 29

Army Urban Operations Training Strategy 29
Army After Next 29
Ballistic Protection for Individual Survivability 30
Coalition Headquarters Design Conference 30
Combined Arms MOUT Task Force (CAMTF), Doctrine Update Effort 31
Counter-Sniper ACTD 31
Force XXI Land Warrior 32
Joint Contingency Force Advanced Warfighting Experiment 32
Objective Individual Combat Weapon (OICW) ATD 33
Precision Offset High-Glide Aerial Delivery of Munitions and Equipment 33
Precision-Guided Mortar Munition ATD 34
RAND MOUT Conference 34
RAND MOUT Conference (2000) 35
RAND MOUT Conference (2001) 35
Rapid Mapping Technology 35
Rapid Terrain Visualization ACTD 36
US Army Combined Arms Urban Operations Training Strategy Implementation 36
USA Military Operations in Urban Terrain Conference 37
Urban Tactical Planner 37

US Marine Corps 38

Attacks on Critical Infrastructure Wargames 38
Center for Emerging Threats and Opportunities (CETO) 38
Clear Facilities Program 39
Cultural Intelligence Handbook 39
Emerald Express Conference Series 40
Marine Air Ground Task Force Intelligence Officer Course (MIOC) and Ground Intelligence Officer Course (GIOC) Urban IPB Exercises 40
Marine Corps Urban Close Air Support Assessment 40
Marine Corps Urban Working Group 41

Project Battalion Staff Urban Planning and Considerations Wargame 41
Project Metropolis (ProMet) 42
Small Unit Logistics ACTD 42
Small-Unit Remote Scouting System (SURSS) [Proposed] 43
Urban Combined Arms Exercise [Proposed] 43
Urban Generic Information Requirements Handbook (GIRH) 43
Urban Generic Information Requirements Handbook (GIRH) Rewrite 44
Urban Reconnaissance Development Program [Proposed] 44
Urban Warrior 44
Yuma Range Urban Training Complex (Yodaville) 45

US Navy 46

Blast Fragmentation Hellfire II 46
Extending the Littoral Battlespace (ELB) ACTD 46
Naval War College Urban Operations Course 47

Defense Advanced Research Projects Agency 48

Advanced Consequence Management 48
Alternatives to Antipersonnel Landmines 48
Battlefield Awareness and Data Dissemination ACTD (BADD) 49
Human ID at a Distance 49
Command Post of the Future (CPOF) 50
Dog's Nose/Unexploded Ordnance (UXO)Detection Program 50
Exoskeletons for Human Performance Augmentation 51
Low-Power Radio Frequency Electronics 51
Metal Storm 52
Mobile Autonomous Robot Software (MARS) Project 52
Micro Air Vehicles 53
MicroElectroMechanical Systems (MEMS) 54
Personnel Protection 55
Small Unit Operations (SUO) 56
Smart Sensor Web 57
Tactical Mobile Robotics (TMR) 57

Intelligence Community....58

Defense Intelligence Agency's Intelligence Support to Urban Operations Conference After-Action Report.... 58

Defense Intelligence Agency, Military Operations in Built-up Areas (DIA MOBA).... 58

Defense Intelligence Urban Operations Working Group (DIUOWG).... 59

How They Fight — Issue on MOUT.... 59

HUMINT and Counterintelligence Support Tools.... 60

Integrated Collection Management (ICM) ACTD.... 60

National Ground Intelligence Center/Marine Corps Intelligence Activity Joint Urban Task Force (NGIC/MCIA Joint Urban Task Force).... 61

National Imagery and Mapping Agency Urban Geospatial Information Program (NIMA).... 61

Urban Intelligence Preparation of the Battlefield ACTD (Urban IPB ACTD) [Proposed].... 62

Urban Intelligence Conference.... 62

Joint....63

Advanced Focal Plane Array Technology.... 63

Aircraft Susceptibility Experiment [Proposed].... 63

Beyond Jointness Conference.... 64

En Route Mission Planning & Rehearsal (EMPRS) ACTD.... 65

Handbook for Joint Urban Operations.... 65

Individual Combatant and Small-Unit Operations Simulation.... 66

J2 Decision Support Center Urban Intelligence, Surveillance and Reconnaissance Study.... 66

J6 C^4I Study.... 67

Joint Common Missile.... 67

Joint Conflict and Tactical Simulation (JCATS).... 67

Joint Non-Lethal Weapons Program.... 68

Joint Publication 3-06: Joint Urban Operations.... 69

JWAC Urban Operations Analysis Branch.... 69

Joint Urban Training Study.... 70

Joint Urban Working Group (JUWG).... 70

Joint Warfighting Science and Technology Plan (JWSTP).... 70

Littoral Warfare Division Urban Operations Study.... 71

MOUT ACTD.... 71

Multifunctional Fabric System 72
Multinational Information Sharing & Collaboration LOEs 72
Multiwavelength Multifunction Laser 72
National Defense University Urban Operations Course 73
Next-Generation Multifunction Electro-Optical Sensor System 73
Objective Crew-Served Weapon (OCSW) ATD 74
Protective Materials for Combatant and Combat Systems Against Conventional Weapons 74
RAND-MCWL-J8 UWG Urban Operations Conference 75
Tactical Operations Support 75
Tactical UAV ACTD 76
Vanguard ACTD [Proposed] 76

Office of the Secretary of Defense (OSD 77

Consequence Management ACTD 77
DoD Urban Operations Journal Website 77
DoD Urban Roadmap 78
GAO Report on MOUT 78
JAWP Technology Workshop 78
Office of the Secretary of Defense Urban Working Group (OSD UWG) 79
Project Lincolnia 79
Project Lincolnia II 79
Urban Operations Knowledge Center 80

Unified Commands 81

Advanced Tactical Laser ACTD 81
Battle Damage Assessment in Joint Targeting Toolbox 81
Consequence Management Exercise (Tempo Brave) 82
Pathfinder ACTD [Proposed] 82
Preemptive IRCM (PIRCM) Prototype System [Proposed] 83
SOCOM Urban Working Group (SOCOM UWG) 83
Special Operations Forces Urban Wargame/Seminar 84
Urban Target Detection and Identification Using Multi-Spectral and Hyperspectral Imaging (Urban MSI/HIS) [Proposed] 84

Allied **85**

Multinational Experimental Symposium 85

NATO SAS-035 Nonlethal Weapons Measures of Effectiveness 85

NATO Urban Operations in the Year 2020 Study 85

United Kingdom Urban Conference 86

Programs by Title

Advanced Consequence Management, 48
Advanced Focal Plane Array Technology, 63
Advanced Tactical Laser ACTD, 81
Aerospace Operations in Urban Environments, 13
Air Force MOUT Conference, 13
Air Force Urban Operations Seminar, 13
Aircraft Susceptibility Experiment, 63
Alternatives to Antipersonnel Landmines, 48
Army After Next, 29
Army Urban Operations Training Strategy, 29
Attacks on Critical Infrastructure Wargames, 38
Ballistic Protection for Individual Survivability, 30
Battle Damage Assessment in Joint Targeting Toolbox, 81
Battlefield Awareness and Data Dissemination ACTD (BADD), 49
Beyond Jointness Conference, 64
Blast Fragmentation Hellfire II, 46
Center for Emerging Threats and Opportunities (CETO), 38
Clear Facilities Program, 39
Coalition Headquarters Design Conference, 30
Combat Missions IRCM (CMIRCM) Prototype System, 14
Combined Arms MOUT Task Force (CAMTF), Doctrine Update Effort, 31
Command Post of the Future (CPOF), 50
Communication Relay Demonstration, 14
Consequence Management ACTD, 77
Consequence Management Exercise (Tempo Brave), 82
Counter-Sniper ACTD, 31
Cultural Intelligence Handbook, 39
Day/Night EO/IR Tracker CM, 15
Defense Intelligence Agency, Military Operations in Built-up Areas (DIA MOBA), 58
Defense Intelligence Agency's Intelligence Support to Urban Operations, 58
Defense Intelligence Urban Operations Working Group (DIUOWG), 59
DoD Urban Operations Journal Website, 77
DoD Urban Roadmap, 78
Dog's Nose/Unexploded Ordnance (UXO)Detection Program, 50
Emerald Express Conference Series, 40
En Route Mission Planning & Rehearsal (EMPRS) ACTD, 65
Exoskeletons for Human Performance Augmentation, 51
Extending the Littoral Battlespace (ELB) ACTD, 46
Force XXI Land Warrior, 32
GAO Report on MOUT, 78
Global Positioning Satellite Airborne Pseudolite (GAP), 16
Guardian, 15
Handbook for Joint Urban Operations, 65
How They Fight – Issue on MOUT, 59
Human ID at a Distance, 49
HUMINT and Counterintelligence Support Tools, 60
Individual Combatant and Small-Unit Operations Simulation, 66
Integrated Collection Management (ICM) ACTD, 60
J2 Decision Support Center Urban Intelligence, Surveillance, 66
J6 C^4I Study, 67
JAWP Technology Workshop, 78
Joint Common Missile, 67
Joint Conflict and Tactical Simulation (JCATS), 67
Joint Contingency Force Advanced Warfighting Experiment, 32
Joint Non-Lethal Weapons Program, 68

Joint Publication 3-06: Joint Urban Operations, 69

Joint Urban Training Study, 70

Joint Urban Working Group (JUWG), 70

Joint Warfighting Science and Technology Plan (JWSTP), 70

JWAC Urban Operations Analysis Branch, 69

Light Weight Modular Support Jammer, 16

Littoral Warfare Division Urban Operations Study, 71

Low-Cost Persistent Area Dominance Miniature Missile (LOCPAD), 17

Low-Power Radio Frequency Electronics, 51

Marine Air Ground Task Force Intelligence Officer Course (MIOC) and Ground Intelligence Officer Course (GIOC) Urban IPB Exercises, 40

Marine Corps Urban Close Air Support Assessment, 40

Marine Corps Urban Working Group, 41

Metal Storm, 52

Micro Air Vehicles, 53

MicroElectroMechanical Systems (MEMS), 54

Military Intelligence Tactical Element (MITE), 17

Mobile Autonomous Robot Software (MARS) Project, 52

MOUT ACTD, 71

Multi-Function Laser Radar, 18

Multifunctional Fabric System, 72

Multinational Experimental Symposium, 85

Multinational Information Sharing & Collaboration LOEs, 72

Multiwavelength Multifunction Laser, 72

National Defense University Urban Operations Course, 73

National Ground Intelligence Center/Marine Corps Intelligence Activity Joint Urban Task Force (NGIC/MCIA Joint Urban Task Force), 61

National Imagery and Mapping Agency Urban Geospatial Information Program (NIMA), 61

NATO SAS-035 Nonlethal Weapons Measures of Effectiveness, 85

NATO Urban Operations in the Year 2020 Study, 85

Naval War College Urban Operations Course, 47

Nevada Training Initiative--Urban Target Array, 18

Next-Generation Multifunction Electro-Optical Sensor System, 73

Objective Crew-Served Weapon (OCSW) ATD, 74

Objective Individual Combat Weapon (OICW) ATD, 33

Office of the Secretary of Defense Urban Working Group (OSD UWG), 79

Pathfinder ACTD, 82

Personnel Protection, 55

Precision Offset High-Glide Aerial Delivery of Munitions and Equipment, 33

Precision-Guided Mortar Munition ATD, 34

Preemptive IRCM (PIRCM) Prototype System, 83

Project Battalion Staff Urban Planning and Considerations Wargame, 41

Project Lincolnia, 79

Project Lincolnia II, 79

Project Metropolis (ProMet), 42

Protective Materials for Combatant and Combat Systems, 74

Pseudolite Near-Far Receiver, 19

RAND MOUT Conference, 34

RAND MOUT Conference (2000), 35

RAND MOUT Conference (2001), 35

RAND-MCWL-J8 UWG Urban Operations Conference, 75

Rapid Mapping Technology, 35

Rapid Terrain Visualization ACTD, 36

Remote Receive Concept (Taclink), 19

Sensor Technology for Difficult Targets Study, 21

SensorCraft Demonstrator, 20

Small Diameter Bomb, 21

Small Unit Logistics ACTD, 42

Small Unit Operations (SUO), 56

Small-Unit Remote Scouting System (SURSS), 43

Smart Sensor Web, 57

SOCOM Urban Working Group (SOCOM UWG), 83

Special Operations Forces Urban Wargame/Seminar, 84

Spectral Infrared Remote Imaging Transition Testbed, 22

Spectre Kite (Control of Tactical UAV from AFSOC Aircraft), 22

Strix Covert Emplacement Dispenser, 23

Surface Extraction and Robust Geolocation for Urban Mapping, 23

Tactical Mobile Robotics (TMR), 57

Tactical Operations Support, 75

Tactical UAV ACTD, 76

Tactical UAV Support to Small Scale Contingencies (SSCs), 24

Three-Dimensional Imaging Laser Radar, 24

Time Synchronization Among Moving Platforms, 25

UAV Delivered Sensors (UDS), 25

UAV Operational Concepts Study, 26

UAV to Fighter Imagery Relay (UFIR), 26

United Kingdom Urban Conference, 86

Urban and Obscured Target Detection and ID, 27

Urban Combined Arms Exercise, 43

Urban Generic Information Requirements Handbook (GIRH), 43

Urban Generic Information Requirements Handbook (GIRH) Rewrite, 44

Urban Intelligence Conference, 62

Urban Intelligence Preparation of the Battlefield ACTD (Urban IPB ACTD), 62

Urban Operations Knowledge Center, 80

Urban Reconnaissance Development Program, 44

Urban Tactical Planner, 37

Urban Target Detection and ID Sensor System Concept, 28

Urban Target Detection and Identification Using Multi-Spectral and Hyperspectral Imaging (Urban MSI/HIS), 84

Urban Warrior, 44

US Army Combined Arms Urban Operations Training Strategy Implementation, 36

USA Military Operations in Urban Terrain Conference, 37

Vanguard ACTD, 76

Yuma Range Urban Training Complex (Yodaville), 45

Explanation of Terms Used in This Appendix

Dates: Denotes the time span of program activity.

Cost: Data provided (when available) reflects total costs over the specified fiscal years.

Outlook: Envisioned timeframe when the benefits of a program will be realized. Near (<5 years), mid- (5-10 years), or long-term (>10 years).

Focus: Letters before the slash denote the phase(s) of urban operations that the program is aimed at Understand (U), Shape (S), Engage (E), Consolidate (C), and Transition (T).

Letters after the slash denote which facets of military capability the improvements will be realized through:

Doctrine (D)
Organization (O)
Training (T)
Materiel Development (Md)
Leadership Education (L)
Policy and Legal (P)
Modeling and Simulation (Ms)
Concept Development and Experimentation (Con)

Sponsor: Leading participant(s) in the activity.

POC/More Information: Individual who can provide more information.

US Air Force

Aerospace Operations in Urban Environments			
An Air Force-sponsored Rand study on the role of aerospace in MOUT. The 265-page book, published in 2000, contains chapters on: preventing the urban fight, legal/political constraints, urban physical environment constraints, new operational concepts, enabling technologies, and historical lessons learned.			
Dates:	published 2000	**Cost:**	
Outlook:	Near/Mid-term	**Focus:**	USE/Con
Sponsor:	Air Force/Rand		
POC/More Information:	Alan Vick, alan_vick@rand.org		

Air Force MOUT Conference			
This two-day conference, *The Role of Aerospace Power in Joint Operations*, involved ~200 participants from the Air Force, academia, and the policy and operational communities. The focus was on what direction the Air Force should take toward future urban operations in the context of joint operations. It was held at Hurlburt Field, Florida.			
Dates:	2QFY99	**Cost:**	
Outlook:	Near/Mid/Far-term	**Focus:**	
Sponsor:	Air Force		
POC/More Information:	Mr. Joe Ellis, AF/XPXT, 703-696-7715, joseph.ellis@pentagon.af.mil		

Air Force Urban Operations Seminar			
This seminar involved briefings by J8 and NDU, followed by discussion of the role of aerospace power in urban operations. The sponsor was the Air Force's Directorate of Strategic Planning.			
Dates:	2QFY01	**Cost:**	
Outlook:	Near/Mid/Far-term	**Focus:**	USECT/DOTMdCon
Sponsor:	Air Force		
POC/More Information:	Mr. Joe Ellis, AF/XPXT, 703-696-7715, joseph.ellis@pentagon.af.mil		

Combat Missions IRCM (CMIRCM) Prototype System [Proposed]			
See PIRCM Prototype System for urban background and Day/Night EO/IR Tracker CM ATD for requisite technology risk reduction. The objective of the CMIRCM ATD is to demonstrate the technologies needed for advanced multi-function EO/IR countermeasures required to defeat 21st century IR/EO missile threats to high performance and low observable combat aircraft such as the F-22 and JSF. The ATD focus will be on affordability through multi-function and modular architecture design philosophy. Advanced semiconductor laser sources, solid state laser beam steering, multi-spectral sensors and imaging seeker expendable countermeasures currently funded under technology programs will mature sufficiently for advanced development demonstration testing. The Combat Aircraft IRCM ATD will develop a compact multi-function EO/IR countermeasures prototype for ground, cable car and flight testing of advanced laser, expendable, and combined countermeasures concepts. The prototype will be fully functional including missile/tracker warning & handoff, and countermeasures capability. System performance will be examined in digital and hardware-in-the-loop simulation followed by static and dynamic testing including live missile events at cable car installations. Flight testing on a drone and manned aircraft is planned if funding permits.			
Dates:	FY04-07	**Cost:**	$23.37 million
Outlook:	Far-term	**Focus:**	S/Md
Sponsor:	Air Force		
POC/More Information:	Capt Michael Hawks, AFRL/SNJW, 937-255-4174x4009, Michael.Hawks@wpafb.af.mil		

Communication Relay Demonstration			
This effort explored the use of high altitude UAVs for communications relay. Currently there is no dedicated beyond line-of-sight (LOS) communications relay available for deployed forces. Through the integration of JTIDS/TADIL-J and VHF/UHF relays a high altitude UAV can provide extended command and control communications between elements such as the Air Operations Center (AOC), the Expeditionary Operations Center (EOC), Control and Reporting Centers (CRC) and forward deployed aircraft.			
Dates:	Aug-Sep 98	**Cost:**	$600K
Outlook:	Mid-term	**Focus:**	US/Con
Sponsor:	Air Force		
POC/More Information:	Capt Frank Shillingford, UAVB/DOM, 872-6656 x 229 (850) 882-6656, francis.shillingford@eglin.af.mil		

Day/Night EO/IR Tracker CM			
This Day/Night Electro-Optical/Infrared Tracker Countermeasures effort is aimed at defeating/denying the use of passive infrared fire control systems and active laser trackers. This would assist in protecting aircraft from both man-portable and larger SAM systems. The "Day/Night" ATD will develop advanced launcher detection and jamming techniques compatible with DIRCM IR missile countermeasure systems. "Day/Night" will 1) detect threats prior to missile launch and beyond missile range, enabling avoidance, denial, and/or attack, 2) deny enemy the ability to operate passively (forcing active radar use) and increases survivability, and 3) is the only effort that addresses beam-rider threats. The Day/Night ATD will define, design, develop, fabricate, assemble and test, in a realistic environment, a flight-worthy demonstrator system. The demonstrator will be capable of detecting, tracking, jamming and/or damaging adjunct tracker systems using laser-based countermeasures. Flight-testing will be accomplished on a C-130 platform or other suitable surrogate platforms to mature the technologies and show military capabilities of a future system. Realistic flight test scenarios, including urban operations, will simulate actual conditions likely to be encountered in future military actions. Threats planned for use in these tests will be actual fire control hardware or suitable simulators.			
Dates:	FY02 – FY07	**Cost:**	$18.1M
Outlook:	Mid-term	**Focus:**	S/Md
Sponsor:	Air Force		
POC/More Information:	Capt Michael Hawks, AFRL/SNJW, 937-255-4174x4009, Michael.Hawks@wpafb.af.mil		

Guardian			
The Guardian (P-20b) system is a rotary-wing UCAV for detecting and attacking both mobile and fixed targets. It will be capable of both autonomous and controller-directed operations. Once launched from an air platform it would patrol a designated area in support of other UCAVs (see description of MITE), or operate independently. Armament would include: a 50Kw Pulse Laser for non-lethal applications, a P-90 gun with 100 rounds for lethal engagement, and a 16 recoilless rounds (20mm) for suppression duties. Cost per system is currently estimated at ~$50K. IOC for Guardian is estimated at FY10-13.			
Dates:	FY01+	**Cost:**	
Outlook:	Far-term	**Focus:**	E/MdCon
Sponsor:	Air Force		
POC/More Information:	Gregory K. Jenkins, Chief Advanced Concepts, Plans & Programs; Armament Product Directorate 207 West D Ave., Ste 308, Eglin AFB, FL 32542 Voice: 850.882.2746x6077 FAX: 850.882.0768 DSN 872 STU3 x6062 Jenkinsg@eglin.af.mil SIPRNET: jenkinsg@afdtc.eglin af.smil.mil		

Global Positioning Satellite Airborne Pseudolite (GAP)			
Demonstrate the military worth of using UAVs to protect and prevent the use of satellite navigation systems. Utilize pseudolite attributes of UAVs, and satellite navigation technology to mitigate hostile use of satellite navigation by unfriendly forces while ensuring unimpeded use of the GPS for US and Allied forces. Demonstration proved that UAVs can augment GPS satellites, can aid in Direct Y signal acquisition, mitigate jamming and deny GPS signal to adversaries. This demonstration has applicability for urban operations to protect US and allied use od GPS over an urban environment.			
Dates:	COMPLETED OCT 99 – MAY 00	**Cost:**	$975K
Outlook:	Mid-term	**Focus:**	S/Md
Sponsor:	Air Force (UAVB, ACC, AC2ISRC, SPAWAR, DARPA)		
POC/More Information:	Maj Rob Bunch, UAVB/DOK, 872-5940 (850) 882-5940, robert.bunch@eglin.af.mil		

Light Weight Modular Support Jammer [Proposed]			
The objective of this Critical Experiment (CE) is to build and flight test demonstrate an affordable, digitally controlled support jammer system(s). These systems will be lightweight and modular in design so that they can readily be adapted to UAVs and fighter aircraft ECM pods, as well as small internal air vehicle installations. A family of modules will include very low cost options that can be installed in expendable UAV payloads and expendable ground implantable jammers. In order to lower the cost of the modules, maximum reliance will be placed on COTS components and other technologies having relatively high levels of technical maturity. The main emphasis of this CE will be on the long neglected "low frequency" radar spectrum (below 4.0 GHz). This technology will be focused on the search and acquisition radars found between VHF and 4.0 GHz frequencies and typically countered by support jammer assets. The modular system(s) to be developed will provide baseline technology for all future light weight and expendable support jammers, and will be at the heart of future advanced support jamming concepts. The program will develop and flight test demonstrate affordable technologies for airspace buyback through enhanced jamming responses against hostile, neutral, and/or friendly threats at much greater ranges than currently achieved.			
Dates:	FY02-FY06	**Cost:**	$5.6 million
Outlook:	Mid-term	**Focus:**	S/Md
Sponsor:	Air Force		
POC/More Information:	Dave Misek, AFRL/SNZW, 937-255-5900, x4280, David.Misek@wpafb.af.mil		

Low-Cost Persistent Area Dominance Miniature Missile (LOCPAD)			
This low-cost (~$35K) and light-weight (sub-150 lbs) munition could be air launched from almost any platform. Multiple LOCPADs would be launched to form cooperative missile grids, acting individually or in swarms. LOCPAD would use LOCAAS or LOCAAS follow-on automatic target recognition techniques to acquire, track, and identify appropriate targets, then apply target dependent kill mechanisms against vulnerable aim points for optimal effectiveness in the lethal engagement case. The three operating modes would include: full autonomous, command assisted, and command directed. Once located, targets could be engaged by one or two of the onboard independently deployable micro munitions, or by direct attack with the missile's internal warhead. The network of LOCPADs would prolong the ISR capability of each missile by only ordering dive attacks when micro munition supplies were exhausted. IOC for LOCPAD is estimated at FY07-FY11.			
Dates:	FY01+	**Cost:**	
Outlook:	Mid-term	**Focus:**	UE/MdCon
Sponsor:	Air Force		
POC/More Information:	Gregory K. Jenkins Chief Advanced Concepts, Plans & Programs; Armament Product Directorate 207 West D Ave., Ste 308, Eglin AFB, FL 32542 Voice: 850.882.2746x6077 FAX: 850.882.0768 DSN 872 STU3 x6062 Jenkinsg@eglin.af.mil SIPRNET: jenkinsg@afdtc.eglin af.smil.mil		

Military Intelligence Tactical Element (MITE)			
The MITE UCAV would have the capability to be employed in escort, search, perch, report, fire and maneuver modes. It would be armed with two internally mounted 20mm recoilless rockets with a time to target detonation feature for improved effectiveness versus targets inside structures, in defilade, or targets in the open. MITE would be a part of the lowest element of the overall urban situational awareness hierarchy. It could sweep indoor and underground locations by flying inside structures and sewers. The limitation of these interior excursions would only be limited by the robustness of communications back to a Weapon System Operator. Envisioned IOC is FY09-FY11. Estimated cost per unit is $35K.			
Dates:	FY01+	**Cost:**	
Outlook:	Mid-term	**Focus:**	UE/MdCon
Sponsor:	Air Force		
POC/More Information:	Gregory K. Jenkins Chief Advanced Concepts, Plans & Programs; Armament Product Directorate 207 West D Ave., Ste 308, Eglin AFB, FL 32542 Voice: 850.882.2746x6077 FAX: 850.882.0768 DSN 872 STU3 x6062 Jenkinsg@eglin.af.mil SIPRNET: jenkinsg@afdtc.eglin af.smil.mil		

Multi-Function Laser Radar			
For missions in the highly cluttered and complex urban environment it is essential to have a sensor system capable of utilizing multiple discriminates. The Multi-Function Laser Radar program will develop and demonstrate a laser radar transceiver capable of using multiple discriminate techniques for ground target location and identification, air target combat ID and target designation. The key to a multi-function laser radar system is to develop an agile transmitter and receiver. The transmitter developed under this effort will have the capability to send multiple wavelengths with various pulse formats, as required for the each laser radar functionality. Long-range laser radar vibration sensing will be demonstrated initially, with the following additional functions added and demonstrated incrementally: high temporal range resolution (1-D) imaging, snap shot (2-D) imaging, polarization imaging and laser designation.			
Dates:	FY01 – FY03	**Cost:**	$4 M
Outlook:	Mid-term	**Focus:**	U/Md
Sponsor:	Air Force		
POC/More Information:	Michael Salisbury, AFRL/SNJM, 937-255-9614x222, Michael.Salisbury@wpafb.af.mil		

Nevada Training Initiative — Urban Target Array
The Nevada Training Initiative (NTI) will develop an affordable and durable "Urban Target" array. The array design will consist of modules constructed of inexpensive and durable materials that are environmentally friendly, "green targets". The modules will be easily transportable over common range roads. We will assemble the targets in desired shapes to form representative buildings, generating an urban environment suitable for training aircrews. This will develop their skills of target location, identification, and destruction using precision weapons and associated tactics. ACC/DOR objectives include sighting the project on the Nevada Test and Training Range (NTTR), obtaining funds for the project, and to determine additional infrastructure. The NTTR provides the large airspace and ground space to facilitate a 640-acre target array that could simulate a large urban target area. Additional requirements for scoring and feedback need to be incorporated to produce the required results of training aircrews on the difficulties of identifying targets and achieving the desired destruction results. The armed forces require "urban target" environments to train and hone their skills in identifying and engaging enemy forces in a Military Operations and Urban Terrain (MOUT) environment. The proposed project will solve Air Force test and training capability shortfalls due to the lack of suitable and affordable "urban target" arrays. The "Urban Target" project will support improving the Services' core mission capabilities of its B-2, B-1, B-52, F-22, F-15, F-16, F-14, F-117, F-18, AC-130, A-10, and AV-8 aircrews to accomplish Interdiction and Close Air Support missions through more effective training events. Additionally, the project includes solutions to present Time Critical Targets (TCT) through remotely controlled targets. It will also support the training of Unmanned Air Vehicle (UAV) operators to find and identify ground threats in an urban environment. The project also supports training of space and information operations personnel tasked to perform their operations in urban environments.

Nevada Training Initiative — Urban Target Array			
Dates:	TBD	**Cost:**	$67.9M
Outlook:	Mid-term	**Focus:**	UE/DTMdMaMsConL
Sponsor:	ACC/DOR		
POC/More Information:	Mr. Raul C. Bennett, GS-13, ACC/DOR, raul.bennett@langley.af.mil		

Pseudolite Near-Far Receiver			
The use of satellite geolocation systems such as GPS in Urban environments is often severely limited due to line of sight obstruction and multipath ranging errors both due to the urban canyon effect. Pseudolites located on towers, in buildings, or on UAV's are often proposed as possible GPS enhancements to overcome the above limitations. However, these stronger signals used in band with GPS will mask the satellite signals and suffer from a Near-Far problem. That is the nearer pseudolites also mask the farther pseudolites. The AFRL/SNAR Novel Wideband Receiver program will reduce this masking effect by removing interference due to known stronger signals, thus allowing the Far pseudolite signals and the GPS satellite signals to serve as useful ranging signals. This program will produce a Near-Far Receiver that will be demonstrated during the DARPA GPX pseudolite program.			
Dates:	FY99-02 R&D	**Cost:**	$920K R&D
Outlook:	Mid-term	**Focus:**	S/Md
Sponsor:	Air Force		
POC/More Information:	Pete Howe, AFRL/SNAR, 937-255-5668 x4139, Pete.Howe@wpafb.af.mil		

Remote Receive Concept (Taclink) [Proposed]
This effort will demonstrate the military worth of passing Predator UAV real-time video directly to ground units using a small hand-held receiver in an Urban setting. It will determine the operational utility in merging technology from USMC Viper Pits technology, Touch Screen Control technology and small remote video receive technology. This merging of technology would allow Air Force ground teams, such as Special Tactics Teams, to not only receive Predator Video, but to incorporate a Low Probability of Intercept transmission which allows ground personnel to data burst their location and target information through the Predator to allow discrete communication during a mission. This allows the Predator GCS to see the location of the USAF team on the ground in relationship to the Predator's location and also to allow the ground team to designate a target location and have it appear on a Predator GCS situational awareness screen (such as Powerscene)

Remote Receive Concept (Taclink) [Proposed]			
Dates:	FY 02-03	**Cost:**	$1.5 million (w/o GCS Integration – $500K)
Outlook:	Near-term	**Focus:**	U/MdCon
Sponsor:	Air Force		
POC/More Information:	Maj Stephen M. Bishop, UAVB/DOM, 872-6656 x 236 (850) 882-6656, stephen.bishop@eglin.af.mil		

SensorCraft Demonstrator			
The SensorCraft UAV is designed around a sensor package that balances cost, performance and endurance. This advanced UAV concept puts many of the functions of AWACs (Air Moving Target Indication), Joint Stars (Ground Moving Target Indication, Synthetic Aperture Radar Imaging), and Rivet Joint (Electronic Signal Measurement) as well as ElectroOptic Imaging functionality into a 65,000-ft altitude vehicle with time on station up to 60 hours. The SensorCraft design is a compromise between optimal aerodynamic and engine performance and optimal sensor performance. The key technologies are multifunctional structures (antennae in the structure), on and off-board data processing, high efficiency engines and advanced LO shape laminar flow design (wing span of 200 ft plus). The most innovative aspect of a Sensor Craft UAV is the integration of the large conformal load bearing antenna systems required for lower frequency operations into the structural components of the aircraft. Aerodynamic flow control (active or passive) provides long loiter at altitude. Advanced lightweight bonded structures (composite or metallic) and ultra fuel-efficient engines with integral starter generators and magnetic bearings that eliminate engine lubrication complement one another to provide the minimum structural weight fraction with sufficient onboard fuel to meet 60 hours endurance and 4000nm range with credible vehicle size and cost. A large scaled X-plane demonstrator program is envisioned with full up active radar, 360 degree coverage, air-to-air and air-to-ground radar modes, and sufficient onboard processing to detect and track difficult and obscured targets from high altitude and at long range.			
Dates:	FY01 – FY07	**Cost:**	$523M
Outlook:	Far-term	**Focus:**	U/Md
Sponsor:	Air Force		
POC/More Information:	Paul Johnson, AFRL/SNR, 937-255-5218x4263, Floyd.Johnson@wpafb.af.mil, John Perdzock, AFRL/VAC, 937-255-3777 John.Perdzock@wpafb.af.mil		

Sensor Technology for Difficult Targets Study			
This Air Force Scientific Advisory Board 2001 Summer Study focused on target location issues. Urban terrain was one of the areas of emphasis in the study. There was an Urban Targets Panel that looked at the unique aspects of urban terrain. The anticipated publication date is December 2001.			
Dates:	2QFY01-1QFY02	**Cost:**	
Outlook:	Near-term	**Focus:**	U/
Sponsor:	Air Force		
POC/More Information:			

Small Diameter Bomb			
The Small Diameter Bomb (SDB) is a precision-guided weapon system (150-lb to 250-lb class weapon) that enables precision engagement of high value hard and soft targets in an urban environment with minimal collateral damage. The SDB will leverage technology breakthroughs (e.g., GPS-aided INS guidance, seeker, fuse, warhead, and control surfaces) in other precision-guided weapon programs (e.g., JASSM, JDAM, JSOW, etc.) to deliver relatively small unitary warheads against fixed, re-locatable, and mobile targets. The potential of this precision-guided weapon will only be realized if theater- and force-level C2 and ISR architectures are enhanced to provide precise urban target system data and information in the realm of near-real time and real time. Additionally, the unit-level mission, route, and weapon-planning environment must be enhanced to meld near-real-time and real-time operational and intelligence data into an urban combat mission data load for the launch platform and weapon. Finally, integrated, automated combat assessment processes and tools will enable decision makers and warfighters to evaluate the results of employing the Small Diameter Bomb in an urban environment and determine follow-up actions (i.e., re-strike).			
Dates:	1QFY96-4QFY10	**Cost:**	$600 Million
Outlook:	Near-term	**Focus:**	E/Md
Sponsor:	Air Force		
POC/More Information:	Ms Lynda Rutledge, AAC/YV, lynda.rutledge@eglin.af.mil		

Spectral Infrared Remote Imaging Transition Testbed			
The objective of the SPIRITT ATD is to develop a day/night, high-altitude, hyperspectral reconnaissance sensor testbed. This testbed will be used to demonstrate the technology for transition to the high-altitude airborne platforms, as well as to serve as a risk reduction platform for space hyperspectral technology. The SPIRITT ATD will develop an HSI sensor system with an integrated high resolution day/night imaging system engineered to fit within both the Global Hawk E-O Bay and the U-2 Q-Bay. This new EO/IR payload will be able to fly concurrently with other reconnaissance assets for an integrated multi-INT capability. The SPIRITT payload will also be designed to serve as a replacement E-O payload for the Global Hawk UAV with significantly enhanced capabilities. In both the Global Hawk and U-2 configurations, the sensor system will support a real-time on-board processing capability for rapid precision targeting. It will also support full data recording for longer term MASINT exploitation for targets of interest to the Intelligence Community. The resulting SPIRITT sensor system will provide an HSI collection capability that can be leveraged to support joint urban operations. HSI data is expected to provide a material identification capability that will enhance target detection and identification, site/facility monitoring, and urban operations planning.			
Dates:	FY01-05	**Cost:**	$20M
Outlook:	Mid-term	**Focus:**	U/Md
Sponsor:	Air Force		
POC/More Information:	Barry Karch, AFRL/SNJT, 937-255-5922 x291, Barry.Karch@wpafb.af.mil		

Spectre Kite (Control of Tactical UAV from AFSOC Aircraft) [Proposed]			
This effort would demonstrate the military worth and operational feasibility of placing TCS Level 4 assets on board a variety of aircraft to control a tactical/small UAV during the terminal phases of an urban operation support mission. The benefits of gaining control of the UAV to find/identify and track targets threatening joint forces involved in low-scale contingency operation would be explored. This effort would further exploit the successes of the UAV Small Scale Contingency demonstration and the UFIR (UAV to Fighter Imagery Relay) to disseminate video information to forces involved in the operation and improve the combat reaction time to put ground suppression fire on target or quickly locate areas of interest without placing either manned aircraft or larger UAVs (such as Predator) at risk. This would provide the commander with another tool to more effectively deal with small-scale contingency missions by allowing the direct feed and control of a UAV using airborne command aircraft such as the AC-130.			
Dates:	FY 03-04	**Cost:**	$1.8M
Outlook:	Near/Mid-term	**Focus:**	US/Md
Sponsor:	Air Force		
POC/More Information:	Maj Stephen M. Bishop, UAVB/DOM, 872-6656 x 236 (850) 882-6656, stephen.bishop@eglin.af.mil		

Strix Covert Emplacement Dispenser			
The Strix vehicle is designed to be a covert emplacement dispenser for IW, lethal and non-lethal payloads. It is compatible with predator carriage and deployment capabilities.			
Dates:	1QFY03-4QFY05	**Cost:**	Sub-$10 million for development
Outlook:	Near-term	**Focus:**	SE/MdCon
Sponsor:	Air Force		
POC/More Information:	Gregory K. Jenkins, Chief Advanced Concepts, Plans & Programs; Armament Product Directorate, 207 West D Ave., Ste 308, Eglin AFB, FL 32542 Voice: 850.882.2746x6077 FAX: 850.882.0768 DSN 872 STU3 x6062 Jenkinsg@eglin.af.mil SIPRNET: jenkinsg@afdtc.eglin af.smil.mil		

Surface Extraction and Robust Geolocation for Urban Mapping			
The Surface Extraction and Robust Geolocation (SERG) concept will combine traditional stereo imagery, Laser Radar imagery (Ladar), and multispectral imagery, all collected with advanced integrated GPS and Inertial navigation. Traditional stereo imagery derives geolocation accuracies using surveyed ground control points within the imagery. Newer mapping techniques are reducing the dependence on these control points using GPS and Inertial navigation measurements on the collection platform. This reference information is projected to the geographic surface and used as the basis for image fusion and geospatial extraction. SERG will fuse Ladar with stereo imagery to improve height accuracy and enable the extraction of surface discontinuities such as buildings in urban settings. SERG will also fuse multispectral imagery to extract surface material types to aid in surface classification and target recognition functions. The technical effort will result in a powerful integrated mapping system capable of satisfying both military and civilian requirements. It will also provide a technical foundation for future developments such as fully automatic surface reconstruction and semi-automatic object recognition systems.			
Dates:	FY00-02 R&D, FY02-06 Install	**Cost:**	$800K R&D
Outlook:	Near/Mid-term	**Focus:**	U/Md
Sponsor:	Air Force		
POC/More Information:	Sandra Berning, AFRL/SNAR, 937-255-5668x4140, Sandra.Berning@wpafb.af.mil		

Tactical UAV Support to Small Scale Contingencies (SSCs)			
This effort aimed to demonstrate the military utility of using a tactical vertical takeoff and landing (VTOL) Unmanned Aerial Vehicle (UAV) to pass real-time video directly to Air Force Special Operations air and ground units in a Small Scale Contingency (SSC) environment. This USAF Battlelab Initiative assessed a VTOL UAV's capability to enhance a deployed force's ability to execute a non-combatant evacuation operation (NEO), and a humanitarian relief operation (HUMRO). The demonstration found that information provided from a tactical VTOL UAV has the potential to assist Special Operations Forces conducting SSC missions. It highlighted the military utility and effectiveness of integrating an airborne platform, AFOSC ground elements, and a UAV to provide situational awareness to all forces simultaneously.			
Dates:	completed Nov 99	**Cost:**	$480K
Outlook:	Mid-term	**Focus:**	U/DTMdCon
Sponsor:	Air Force		
POC/More Information:	Maj Stephen M. Bishop, UAVB/DOM, 872-6656 x 236 (850) 882-6656, stephen.bishop@eglin.af.mil		

Three-Dimensional Imaging Laser Radar [Proposed]			
The significant vertical structure found in most urban environments makes imaging and mapping of the environment quite difficult. The Three-Dimensional Imaging Laser Radar program will develop and demonstrate a laser radar transceiver capable of rapid imaging and mapping based on acquisition of full three-dimensional images on each pulse transmitted by the laser radar. These smaller images would then be "stitched" together to form the complete image. The key to such a system is a focal plane array receiver that provides range profiling per pixel. Such a focal plane is currently under development in a DARPA-sponsored program. The Three-Dimensional Imaging Laser Radar program will integrate the focal plane technology with appropriate transmitter technology and demonstrate the imaging and mapping functions from an airborne platform.			
Dates:	FY03 – FY06ar	**Cost:**	TBD
Outlook:	Mid-Term	**Focus:**	U/Md
Sponsor:	Air Force		
POC/More Information:	Michael Salisbury, AFRL/SNJM, 937-255-9614x222, Michael.Salisbury@wpafb.af.mil		

Time Synchronization Among Moving Platforms			
Future aerospace systems will depend on increasingly precise time and frequency coherence between aerospace platforms including aircraft, spacecraft, weapons in flight, and unattended ground sensors. The dependent systems will include LPI, LPD communications, multistatic sensors (multi-platform ESM, bistatic radar), and synthesized array sensors. Timing requirements will range from tens of nanoseconds to tens of picoseconds depending on the application. The best available technology for military users is either GPS or Link-16, which typically provides 30 to 100 nanosecond time synchronization for moving users or dedicated data links that provide sub-nanosecond time for stationary users. The planned programs will build on existing work being performed at the AFRL, DARPA, Navy (NRL and SPAWAR) and the NRO. Enabling technologies for this capability include improvements to miniature clocks, time synchronization through GPS, direct data links or satellite relays, and algorithms for dealing with multipath and relativistic effects. This program will perform requirements analyses, design, build and test flyable equipment capable of testing the ability to achieve time and frequency coherence between a variety of dynamic platforms. This will include the examination of (1) strengths/weaknesses of existing time transfer techniques; (2) existing DoD/Civilian time transfer techniques to determine which, if any, capabilities can be further developed to achieve the required precision; and (3) expanding and testing identified techniques to determine the tradeoffs between accuracy, precision and physical constraints. This program develops enabling technology required for many Joint Urban functions such as communication, multistatic sensors, and emitter geolocation.			
Dates:	FY02-06 R&D FY05-07 Critical Technology Exper	**Cost:**	$900K R&D $1300K Critical Technology Experiment
Outlook:	Mid-term	**Focus:**	U/Md
Sponsor:	Air Force		
POC/More Information:	Pete Howe, AFRL/SNAR, 937-255-5668 x4139, Pete.Howe@wpafb.af.mil		

UAV Delivered Sensors (UDS)			
This effort will demonstrate the military worth of using UAVs as a sensor delivery platform and release mechanisms for other UAVs. Demonstration will deliver the ARGUS sensor into areas denied to other delivery platforms. Demonstration will attempt to provide a JFACC with a common sensor delivery capability for Predator with less risk to manned systems. Release mechanism commonality will be explored for other sensors which could be dropped by a UAV to include weather sensors, microglider and MALD (Minature Air-Launched Decoy). This effort has considerable potential for MOUT because UAVs could prove very useful in placing sensors on top of buildings or on the periphery of urban areas. Sensor placement accuracy will also be aided by their low altitude delivery.			
Dates:	ONGOING	**Cost:**	$500K
Outlook:	Near/Mid-term	**Focus:**	U/Md
Sponsor:	Air Force (UAVB, ACC, AC2ISRC, AAC)		
POC/More Information:	Maj Rob Bunch, UAVB/DOK, 872-5940 (850) 882-5940, robert.bunch@eglin.af.mil		

UAV to Fighter Imagery Relay (UFIR)			
The goal of this effort was to demonstrate the military worth of using UAVs to relay imagery between fighter aircraft and a Combined Air Operations Center. A Predator UAV will be used to relay pre-strike imagery to fighter aircraft. That UAV will then relay F-16 LANTIRN post-strike imagery to the ISR Battle Manager. The loitering capability of the UAV enhances it ability to relay communications.			
Dates:	Dec 00 – Oct 01	**Cost:**	$494K
Outlook:	Near-term	**Focus:**	U/MdCon
Sponsor:	Air Force		
POC/More Information:	Maj Earl Odom, UAVB/DOK, 872-5940 x 208 (850) 882-5940, earl.odom@eglin.af.mil		

UAV Operational Concepts Study [Proposed]			
This study would explore future joint operational concepts for UAVs to support MOUT. It would consolidate lessons learned from previous studies, (WWII – Aachen Campaign) (JUST CAUSE– Panama) (ASSURED RESPONSE – Liberia) (RESTORE HOPE – Somalia) (SILVER WAKE – Albania) (JOINT GUARD/FORGE – Bosnia) (ALLIED FORCE – Kosovo) and propose how UAVs could be employed to better protect US and allied forces. The study would aim to identify current barriers to a consolidated and effective USAF role in leading aerospace doctrine in MOUT, as well as, possible proposals to make joint UAV efforts more effective. The study may form the baseline for a follow-on UAV Battlelab Joint Initiative, which will show the military utility of using a family of UAVs to approach the urban operations problem. This initiative would use the Predator UAV as a medium-high communications relay for remote control – beyond line of sight operation of Firescout VTOL UAV system or A-160 Hummingbird UAV employing Unmanned Ground Vehicles and Unattended Ground Sensors on top of buildings to establish a sensor web system within an urban area and allow precision targeting and or collection of high value SIGINT. This initiative would also combine lessons learned from the UAVB SSC Demonstration to feed information from the various platforms directly to forces engaged in combat as well as to rear Joint C2ISR Operations Centers. Coordination with, and participation from the USN Program office for Firescout, Marine Corps Warfighting Lab and the Army Battlelabs would ensure a new approach. UAVB plans to sponsor a Warfighter Workshop in the beginning of FY 02.			
Dates:	FY02	**Cost:**	TBD
Outlook:	Near-term	**Focus:**	U/Con
Sponsor:	Air Force		
POC/More Information:	Maj Stephen M. Bishop, UAVB/DOM, 872-6656 x 236 (850) 882-6656, stephen.bishop@eglin.af.mil		

Urban and Obscured Target Detection and ID [Proposed]			
The objective of the Advanced EO-UAV is to provide integrated EO/IR capability for tactical weapon systems to detect, locate, and ID difficult ground targets for day/night operations in the urban battlespace through multiple electro-optic interrogation. The proposed "Urban and Obscured Target Detection and ID" ATD will develop a single, multifunction system with the capability to detect and ID deep hide ground targets, precision 5-D mapping for targeting, urban operations, target detection, and battlefield preparation. The system will apply robust target ID & characterization, facility monitoring/activity, & decoy detection utilizes HSI, polarization, vibration imaging techniques. The system will have the capability to detect and ID deep hide ground targets and difficult air targets. The system will also enable air and ground corridor monitoring. This ATD will exploit all important aspects of the targets including geometric shape, material characteristics (paint/surface), thermal, acoustics and power plant (vibration), and effluents (agents, exhausts and by products) to allow detection and identification of targets previously undetectable in environments previously inaccessible including the urban environment and deep hide targets. Polarimetric HSI/MSI would be combined with wide area, precision 5-D radar mapping (angle-angle-range-intensity-wavelength) for high performance detection and queuing as well as detailed urban mapping/corridor identification, foliage/camouflage detection and poke-thru. When queued, identification and detailed characterization of the target area would be made through polarization diverse active-multi spectral sensing, vibration detection, wind/aerosol detection & characterization, and finally, multi-look reconstruction and fusion of multiple dimensionalities. This effort is based on an extensive technology history with significant supporting programs in passive hyper-spectral sensing, active imaging, 3-D imaging/mapping, active multi-spectral sensing, micro-Doppler based vibration, winds, and aerosols detection, and signal processing.			
Dates:	FY06 – FY10	**Cost:**	TBD
Outlook:	Mid-term	**Focus:**	U/Md
Sponsor:	Air Force		
POC/More Information:	Michael Salisbury, AFRL/SNJM, 937-255-9614x222, Michael.Salisbury@wpafb.af.mil		

Urban Target Detection and ID Sensor System Concept [Proposed]			
This concept will provide the next generation targeting sensor suite for the AC-130 gunship and other weapon systems (A-10s, F-16s, UAVs) supporting Close Air Support missions in the urban environment. Both wide-band and narrow-band sensors covering different spectrum will be co-boresighted in single turrets to provide the sensor operator the spectral coverage necessary for target detection, classification, and identification in the urban environment. Notionally, the Gunship Q-26 long-wave FLIR and AC-130H Low Light Level TV (LLTV) and AC-130U All Light Level TV (ALLTV) will be replaced by multi-spectral sensors integrated into to single turrets. Sensor installation in these turrets may be permanent. Or if camera/sensor technology for all required spectrum is not available at the time of initial development, or if spectral requirements vary sufficiently from mission to mission, cameras may be removable/replaceable in what could be described as a "plug and play" turret. A similar upgrade to the Advanced Tactical Pod would provide fighter platforms an urban sensing capability. Internal integration on a Predator UAV would provide an on-station capability in a medium to high threat environment (minimize the exposure of manned aircraft) or to provide continuous nadir sensor during manned aircraft operations. In order to provide close proximity fire support to engaged ground forces, active, semi-active, and passive sensors in the RF, EO, and IR spectrum will discriminate combatants from noncombatants and provide positive ID of friendly personnel by using RF and EO/IR tags. This IFFN capability will be integrated with the above EO/IR and RF sensors. Emerging ground penetrating and wall penetrating radars, vibrometry, and other innovative sensors will enable airborne and ground platforms to image underground and indoor facilities and to localize activity in order to detect, track, and engage underground/indoor targets.			
Dates:	FY10-14 R&D, FY15-19 Install	**Cost:**	$200 million R&D $136 million gunship installation
Outlook:	Far-term	**Focus:**	U/Md
Sponsor:	Air Force		
POC/More Information:	Walter Harrington, AFRL/SNZC, 937-255-5351x4300, Walter.Harrington@wpafb.af.mil		

US Army

Army Urban Operations Training Strategy			
The CAMTF completed an overarching urban operations training strategy which was approved by the TRADOC Commander in March of 2001 and forwarded to the Chief of Staff of the Army for final approval. The strategy consists of a comprehensive assessment of all domains of the DTLOMS spectrum, was prioritized based on unit type and installation, and includes both active and reserve components. The strategy recommends four new home station urban operations training facilities: a Live Fire Shoot House, Urban Assault Course, Breach Facility, and Combined Arms Collective Training Facility. All four facilities would be capable of providing realistic home station live and blank fire combined arms training in preparation for either a Combat Training Center rotation or actual deployment. Home station facilities consist of a mix of instrumentation and targetry that supports precision marksmanship skills and restrictive rules of engagement normally associated with an urban operation. TC 90-1, *Training for Military Operations on Urbanized Terrain*, is being updated by the CAMTF (due for release 3QFY01) and will explain the four new urban operations training facilities and provides sample scenarios and training support packages for each. The urban operations strategy includes facilities located at the Army's Combat Training Centers, doctrinal update cost estimates, distance learning initiatives, and a modeling and simulation strategy that will support virtual and constructive urban environments and scenarios. Cost estimates in the strategy are broken out by DTLOMS components and initial funding of $129 million was approved in the FY02-07 POM. Remaining required funding was recommended to be spread across the FY03-07 Mini-POM and FY04-09 POM. Initial construction will begin in FY02 at Ft. Lewis, Washington in support of the Army's transformation effort, with remaining construction and instrumentation scheduled through FY09.			
Dates:	FY03-FY09	**Cost:**	$664 million (FY03-FY09)
Outlook:	Mid-term	**Focus:**	USECT/TLMsCon
Sponsor:	Army		
POC/More Information:	Col Cole, Deputy Director CAMTF, DSN 835-3739		

Army After Next			
The goal of the Army After Next effort is to conduct broad studies of warfare to about the year 2025 to frame issues vital to the development of the U.S. Army after about 2010, and provide those issues to senior Army leadership in a format suitable for integration into TRADOC combat development programs. For FY99 the Army After Next effort included urban warfare as one of its areas of emphasis.			
Dates:	FY99	**Cost:**	
Outlook:	Far-term	**Focus:**	
Sponsor:	Army		
POC/More Information:			

Ballistic Protection for Individual Survivability			
This DTO will develop and insert advances in materials technology to increase the protection and performance of armor systems for the individual warfighter while minimizing penalties associated with the increased levels of protection. The program had goals to demonstrate an advanced material system for protection against combined fragmentation and small arms threats (known ball threats up to .30 caliber), to be measured by a 20-30% reduction in area density (weight for given area) over current small arms protection without significantly increasing other penalties. Another goal is to integrate and transition improved technology to advanced development or as technology insertions to modify existing individual protective systems. An additional aim is to transition to advanced development protective materials technology providing protection equal to the FY96 individual countermine protective system at a 35% reduction in system weight. The program will demonstrate an improved material system prototype for second-generation multiple ballistic threat protection (with either an additional 10% decrease in weight, a 10% increase in protection, or a combination, depending on user assessments).			
Dates:	FY97-FY03	**Cost:**	$8.6 million (FY97-FY03)
Outlook:	Near-term	**Focus:**	S/Md
Sponsor:	Army		
POC/More Information:	COL Bosse (Dismounted Battle Space Battle Lab), DSN 835-2310		

Coalition Headquarters Design Conference			
Sponsored by the USA Command and General Staff College and the Association of the USA. Held in October 2000, the event was attended by representatives from the USA, USMC, Joint Staff, and nine military members from other nations. The intent of the conference was to continue the dialog regarding interoperability problems and possible solutions. Aimed at the near-term, recommendations of the attendees included: joint/combined force commanders should place greater importance on who they select for liaison duty (not only communication – but understanding – is key); commanders and their staffs should realize the need to evaluate the capabilities of each participating nation partner in the operation, and assign tasks appropriately; and nations have different cultures that deserve understanding and respect (religious traditions for example).			
Dates:	1QFY01	**Cost:**	
Outlook:	Near-term	**Focus:**	T/
Sponsor:	Army		
POC/More Information:			

Combined Arms MOUT Task Force (CAMTF), Doctrine Update Effort			
CAMTF's focus has been to act as the U.S. Army's central point of contact for urban operations to update doctrine, develop an overarching urban training strategy, and to identify training requirements for the Army out to 2010. The doctrinal update process has been a coordinated effort within the Army. This effort has focused on updating the Army's capstone urban doctrinal manual, FM 3-06 (90-10), *Urban Operations*, which is being conducted at the Combined Arms Center, Ft. Leavenworth, Kansas and the Army's tactical "how to fight" manuals, which primarily include combined arms FMs produced at the Army infantry and Armor Schools. Additionally, input has been received and incorporated from the Army Training and Doctrine Command (TRADOC) proponents, to include the Army Aviation, Armor, Air Defense Artillery, Chemical, Engineer, Field Artillery, Military Intelligence, Medical, Judge Advocate General, Schools; the Army John F. Kennedy Special Warfare Center; and the Army Combat Support Command (CASCOM). The Doctrinal update effort has concentrated on the incorporation of combined arms Full Spectrum Operations (offense, defense, stability, and support) into the doctrinal base, which utilizes the operational concept of Assess, Shape, Dominate, and Transition to find alternatives to using the attrition approach to conducting urban operations. The doctrinal update effort has also incorporated historical lessons learned from 1944 to the present, to include recent military operations in Panama, the Persian Gulf, Somalia, Haiti, Chechnya, Bosnia, and Kosovo. The effort has incorporated the lessons learned from recent Army and Marine Corps experimentation efforts, most notably the MOUT ACTD, rotations of the JRTC, and Project Metropolis. This effort has direct correlation to the formulation of a comprehensive combined arms urban operations training strategy for the Army.			
Dates:	2QFY99-4QFY01	**Cost:**	$1.6 million
Outlook:	Near-term	**Focus:**	USECT/DCon
Sponsor:	Army		
POC/More Information:	Mr. John Bastone, DSN 835-5827, bastonej@benning.army.mil		

Counter-Sniper ACTD			
This was an Army activity to bring the latest sniper detection equipment to DoD customers for evaluation. The goal was to bring state of the art sniper detection capabilities to DoD users for evaluation and to provide interim capability hardware suitable for use in the field.			
Dates:	3QFY96-1QFY97	**Cost:**	
Outlook:	Near-term	**Focus:**	U/Md
Sponsor:	Army		
POC/More Information:	Dr. Charles Perkins, perkincw@acq.osd.mil		

Force XXI Land Warrior			
The Land Warrior System will make rapid deployable light forces more effective on the future battlefield. By leveraging existing technology from industry and other government programs and allowing for the continued integration of mature technologies, an integrated, modular fighting system for the dismounted infantryman is being developed. The LW system includes everything the dismounted soldier wears and carries integrated into a close combat fighting system that enhances his situational awareness, lethality, survivability, mobility, sustainment, and training. Many components of the system will be provided as government furnished property to the LW contractor, e.g. the Battle Dress Uniform and the Joint Service Lightweight Integrated Suit Technology Chemical Protective Ensemble. The system provides the soldier with improved situational awareness, overmatching lethality, high levels of protection, and rapid digital and voice communications. With the Land Warrior System, every soldier knows where he is, where the enemy is, where his buddies are and what he is to do. The soldier can accurately engage targets from cover using the thermal or video sight in his heads up display. The system protects the soldier from bullets, shrapnel, directed energy and chemical weapons. Total system weight is equal to or less than what the soldier carries now, and will be reduced through future components integration and capability enhancements.			
Dates:	began 4QFY95	**Cost:**	$61.7 million (FY97-FY03)
Outlook:	Mid-term	**Focus:**	S/Md
Sponsor:	Army/Marine Corps		
POC/More Information:	Mr. Pat Snow (NRDEC, Chief, Warrior Systems), DSN 256-5436 (new)		

Joint Contingency Force Advanced Warfighting Experiment			
This experiment occurred at the JRTC at Ft. Polk.			
Dates:	3QFY00	**Cost:**	
Outlook:	Near-term	**Focus:**	USE/DOTMdCon
Sponsor:	Army		
POC/More Information:			

Objective Individual Combat Weapon (OICW) ATD			
This program's goal is to develop small arms with greater lethality. The prototype OICW is a 5.56mm assault rifle with a built in 20mm grenade launcher that can fire air-bursting rounds. According to the contractor the OICW's 20mm grenade round is five times more likely to incapacitate a target at 300m than the current 40mm grenade round. Two key technological hurdles for the weapon are cost and weight, currently $15K and 18-lb per weapon. The current effort is scheduled to run through FY04, when the OICW will enter the engineering and manufacturing development phase. Plans are for full production to begin in FY09. The Army's plans are to purchase 20,000 and issue them to four members of each nine-man infantry squad.			
Dates:	FY94-FY04	**Cost:**	$95 million (FY01-FY04)
Outlook:	Mid-term	**Focus:**	E/Md
Sponsor:	Army		
POC/More Information:			

Precision Offset High-Glide Aerial Delivery of Munitions and Equipment			
This effort will demonstrate revolutionary technologies for the reliable precision-guided delivery of combat-essential munitions/sensors and equipment using a high-glide wing technology and a low-cost, modular GPS guidance package and control system. This technology will provide a 6:1 or better glide ratio. The program planned to demonstrate precision high glide of a 5,000-lb payload, using an advanced guidance package and high-glide wing. This technology will significantly enhance military aerial delivery capability through substantially higher glide ratios than are possible with ram air parachutes, and will directly benefit the initial deployment of early entry forces. Technical barriers include accurate characterization of decelerator aerodynamic coefficients of performance for varied payload weights. The program will adapt and integrate modular GPS capabilities to personnel delivery systems and demonstrate advanced airborne insertion technologies providing ultra-high-altitude insertion of individuals and small units with the ability to accurately reach drop zones from increased standoff distances during night and limited visibility conditions. These technologies will enhance the covert mobility of early entry forces in urban terrain areas and greatly improve lethality and survivability. Another goal was to demonstrate a 50% increase in airborne insertion offset distance. Technical barriers include miniaturized GPS/INS airborne personnel navigation capabilities and the integration of improved high-altitude life support technologies.			
Dates:	FY97-FY03	**Cost:**	$16.0 million (FY97-FY03)
Outlook:	Mid-term	**Focus:**	SE/Md
Sponsor:	Army		
POC/More Information:	Mr. Ken Foley (Early Entry, and Survivability Battle Lab (EELS)), DSN 680-5854		

Precision-Guided Mortar Munition ATD			
The 120mm Precision Guided Mortar Munition (PGMM) will provide the battalion with a lethal, surgical strike capability to destroy high value targets beyond line of sight direct fire weapons. The PGMM is a multi-mission, multi-mode precision munition capable of defeating high value point targets at double the range of conventional 120mm mortar ammunition (12km required, 15km desired). Its modes of operation include laser designation and/or autonomous fire and forget, depending on the needs of the mission. Its infrared seeker detects and classifies targets, and inputs information through its processor to its guidance & control subsystems to ensure a direct hit on the target. The shaped charge warhead will defeat both soft and hard targets. The use of operational experiments and high resolution computer simulation are key components in the development of PGMM.			
Dates:	FY95-FY01	**Cost:**	$31.7 million (FY95-FY01)
Outlook:	Mid-term	**Focus:**	E/Md
Sponsor:	Army		
POC/More Information:			

RAND MOUT Conference			
This two-day conference was held in Washington (DC) and was sponsored by RAND and the Army Infantry Center's Dismounted Battlespace Battle Lab (DBBL). The conference had three primary objectives. ▸ The first was to assess the state of current U.S. MOUT capabilities and determine viable approaches to needed changes in two timeframes: 1998-2005, and 2006-2025. ▸ The second objective was to foster debate on new operational concepts, training, and simulation requirements. ▸ The third objective was to determine technologies worthy of consideration in future ACTDs, the Army's Force XXI, and the Army After Next.			
Dates:	2QFY98	**Cost:**	
Outlook:	Near/Mid/Far-term	**Focus:**	
Sponsor:	Army		
POC/More Information:			

RAND MOUT Conference (2000)			
On March 22-23, 2000, RAND's Arroyo Urban Operations team hosted an educational conference on "Capital Preservation: Preparing for Urban Operations in the 21st Century." Over 100 participants from the four U.S. military services, the Department of Defense, the armies of New Zealand, Great Britain, Korea, Germany, Canada, Italy and Russia, and delegates from Israel joined RAND staff to listen to high-ranking military officials from around the world discuss their experiences and lessons learned from past urban operations.			
Dates:	2QFY00	**Cost:**	
Outlook:	Near/Mid/Far-term	**Focus:**	
Sponsor:	Army		
POC/More Information:	Ms. Terri Perkins, perkins@rand.org		

RAND MOUT Conference (2001)			
The objective of this gathering is to provide a forum for information exchange and debate regarding the complete range of possible urban challenges likely to confront the military over the next generation. Titled "Ready for Armageddon," this conference, to be held in Santa Monica, California, features a different focus than the previous RAND MOUT conference. The new goal is not just to simply inform the audience of the challenges inherent during urban contingencies but to actually find solutions to selected problems of notable current relevancy. Speakers will be given problems to which solutions are sought rather than topics on which to speak, and the format will provide significantly more time for audience discussion of issues with speakers.			
Dates:	3QFY01	**Cost:**	
Outlook:	Near/Mid/Far-term	**Focus:**	
Sponsor:	Army		
POC/More Information:	Ms. Terri Perkins, perkins@rand.org		

Rapid Mapping Technology			
This effort looks to develop software and integrate into an automated terrain information system the capability to rapidly extract and properly attribute geospatial information of importance to Army and DoD customers from multiple sources with various resolutions, densities, and formats.			
Dates:	FY97-FY02	**Cost:**	
Outlook:	Mid-term	**Focus:**	U/Md
Sponsor:	Army		
POC/More Information:	Mark Adams (TRADOC), (573) 563-4077		

Rapid Terrain Visualization ACTD			
An Army effort scheduled for FY97-FY01. Its focus is on developing the capability to rapidly generate terrain data for any location and deliver it in a visual format to the consumer. The data would be acquired by tapping preexisting databases and surging ISR assets. As of 2QFY00 the program had completed a detailed technical and operational study and selected an optimum radar and platform for collecting high-resolution digital elevation data. Enhanced semi-automated feature extraction capability was demonstrated using commercial satellite imagery. Collection was completed of high-resolution digital topographic data in support of the XVIII Airborne Corps. Version 3.0 of the semi-automated topographic data generation software was installed and demonstrated at XVIII Airborne Corps testbed and III Corps topographic units.			
Dates:	FY97-FY01	**Cost:**	$11.05 million (FY99-FY01)
Outlook:	Near-term	**Focus:**	U/Md
Sponsor:	Army		
POC/More Information:	Mr. Chris Moscoso, cmoscoso@nul.army.mil		

US Army Combined Arms Urban Operations Training Strategy Implementation			
In March 2001, the Commander, US Army Training and Doctrine Command (TRADOC) approved the US Army Combined Arms Urban Operations Training Strategy. The strategy calls for the synchronization of the live, virtual and constructive (L,V,C) training environments. Between now and FY 10, the US army will build live training facilities that will allow both active and reserve component units to train at home station up to battalion task force level. Construction or upgrade of facilities is currently on the Master Army Range Plan. Additionally, the maneuver combat training centers will also build or upgrade facilities that will permit live urban operations training at the brigade level. The National Simulation Center in coordination with the TRADOC Analysis Center and the TRADOC System Manager for combined arms tactical trainers will develop constructive simulations and virtual simulators that will possess the capability to train urban operations for battle staffs and crews. The L, V, C training facilities, simulators, and simulations will all be doctrinally consistent with the effort described above.			
Dates:	2QFY02-4QFY10	**Cost:**	$664 million
Outlook:	Near/Mid-term	**Focus:**	USECT/T
Sponsor:	Army		
POC/More Information:	Mr. Jeff Arneson, DSN 835-0134, arnesonja@benning.army.mil		

USA Military Operations in Urban Terrain Conference			
This Army sponsored conference was held at Ft. Knox in September, 2000. It was attended by representatives of the U.S. Army, USMC, Joint Staff, and academia (including from Israel). The focus of the conference was to acknowledge the emerging need to address how the U.S. and its allies will operate in urban environments. Issues raised included: a need to revise antiquated urban doctrine, a need to develop joint and combined doctrine, and a need to study how to better operate as a part of a multinational force in an urban setting where Blue, Red and White are all in close proximity, structures dominate, and policy considerations prohibit indiscriminate use of force.			
Dates:	4QFY00	**Cost:**	
Outlook:	Near/Mid/Far-term	**Focus:**	
Sponsor:	Army		
POC/More Information:			

Urban Tactical Planner			
The U.S. Army's Topographical Engineering Center developed the Urban Tactical Planner (UTP). The UTP is a computer generated geo-referenced, urban visualization tool linking imagery and textual data. Initial development was completed in 1997, while upgrades are ongoing. The UTP product can be delivered via CD or SIPRNET.			
Dates:	began FY96	**Cost:**	$160K for development
Outlook:	Near-term	**Focus:**	U/Ms
Sponsor:	Army		
POC/More Information:	Joe Harrison, jfharris@tec.army.mil		

US Marine Corps

Attacks on Critical Infrastructure Wargames			
This series of ongoing wargames explores the use of information warfare to manipulate critical infrastructure in foreign countries. The seminar style wargames try to determine employment concepts of computer network operations that will shape the battlespace and facilitate friendly maneuver.			
Dates:	began FY98	**Cost:**	$30K
Outlook:	Near/Mid-term	**Focus:**	SE/Con
Sponsor:	Marine Corps		
POC/More Information:	Maj. J. S. Sauer, sauerj@mcwl.quantico.usmc.mil		

Center for Emerging Threats and Opportunities (CETO)			
The U.S. Marine Corps and the Potomac Institute for Policy Studies, a technology policies research institute, stood up the Center for Emerging Threats and Opportunities on 20 December 2000. CETO is a partnership between the two organizations dedicated to exploring innovative ways to deal with increasingly complex and non-traditional threats to national security. The center's unique approach aims to facilitate cooperation between the military and other public and private agencies, including the State Department, non-governmental, volunteer, and academic organizations. The objective of the center is to transform its research into operating force capabilities needed by both Marine Corps and joint warfighters for small-scale operations around the world.			
Dates:	stood up 1QFY01	**Cost:**	
Outlook:	Near/Mid/Far-term	**Focus:**	
Sponsor:	Marine Corps		
POC/More Information:	Tim Jones, jonest@mcwl.quantico.usmc.mil		

Clear Facilities Program			
The Clear Facilities program was started by the Joint Non-Lethal Weapons Directorate (JNLWD) taking a survey of the CINCs in 1996 on capabilities required for Non-Lethal missions and tasks. This survey revealed that CINCs required a better ability to Clear Facilities. In 1999, the JNLWD tasked the USMC to lead this Joint Service effort. PM, Non-Lethal/Urban Ops was giving the task of forming this program. The Joint community was surveyed on specific capabilities that are/would be required to conduct clearing operations, and what the target set included. With that basis the program was formed to look at the whole spectrum of capability requirements from the time a unit receives a mission task to conduct a clearing operation until the time the clearing operation is completed. It was also learned from operators that the target sets included in this program would not be limited and would included everything from normal buildings, to ISO containers, aircraft on a tarmac, ships, goplats, and any facility or structure that would normally require a clearing operation to be conducted on it. Subsequently, the program office embarked upon the task of bringing together the appropriate acquisition documentation to propose a Clear Facilities Capstone Requirements Document (CRD) in order to codify the capabilities required to conduct clearing operations and to provide the basis for materiel developers to better acquire materiel solutions for these requirements within the acquisition framework. These activities include: Concept of Operations Development, Development of a Technology Roadmap, Development of a Draft Capstone Requirements Document, Conduct of several Operator input sessions, Development of a Non-Lethal Requirements Document/Program.			
Dates:	FY99+	**Cost:**	
Outlook:	Near-term	**Focus:**	E/Md
Sponsor:	Marine Corps		
POC/More Information:	Maj. Keith Mayo, mayoke@mcsc.usmc.mil		

Cultural Intelligence Handbook			
This Marine Corps Intelligence Activity product is in the early production phase, with an expected publication date of 2QFY02. It is an expansion of MCIA's Urban GIRH and it will incorporate lessons learned from urban exercises, wargames and real world operations.			
Dates:	publication 2QFY02?	**Cost:**	
Outlook:	Near-term	**Focus:**	U/DL
Sponsor:	Marine Corps		
POC/More Information:			

Emerald Express Conference Series			
This ongoing series of conferences brings together military, interagency, and NGO/PVO personnel to refine coordination across a range of in-country activities, from humanitarian to warfighting.			
Dates:	Began FY98	**Cost:**	$10K
Outlook:	Near-term	**Focus:**	ST/T
Sponsor:	Marine Corps		
POC/More Information:	Maj. J. S. Sauer, sauerj@mcwl.quantico.usmc.mil		

Marine Air Ground Task Force Intelligence Officer Course (MIOC) and Ground Intelligence Officer Course (GIOC) Urban IPB Exercises			
Entry and intermediate level training for Marine Intelligence Officers is accomplished at these two formal schools. Beginning in 1999 both schools set aside a portion of their curriculum to devote to Intelligence in a MOUT environment. The focus is on instruction of the basic Intelligence Preparation of The Battlefield concerns as well as execution of several practical exercises in MOUT scenarios. A MOOTW Instruction Package and Practical Exercise covers almost a week of training and focuses on all areas of intelligence support to a MAGTF involved in a Low Intensity Conflict (LIC) against an urban guerilla threat. This change in the curriculum was wrought by the realization that as a Marine Corps we are spending more time in MOUT/LIC environments and tries to prepare intelligence officers to operate efficiently and effectively in MOUT.			
Dates:	Began 1QFY99	**Cost:**	
Outlook:	Near-term	**Focus:**	U/TL
Sponsor:	Marine Corps (Navy and Marine Corps Intelligence Training Center (NMITC))		
POC/More Information:	Major Brian Sullivan, USMC, Maj-Brian.J.Sullivan@cnet.navy.mil		

Marine Corps Urban Close Air Support Assessment			
The purpose of this study was to assess the Marine Corps' urban CAS baseline effectiveness. A total of 338 CAS missions were conducted using AH-1W, UH-1N, AV-8B, and F/A-18 aircraft. One hundred thirteen aircrew, 24 Forward Air Controllers, and 32 Tactical Air Control Party members participated.			
Dates:	completed 2QFY00	**Cost:**	$10K
Outlook:	Near-term	**Focus:**	E/
Sponsor:	Marine Corps		
POC/More Information:	Mr. William Simpson, Williams@mcwl.quantico.usmc.mil		

Marine Corps Urban Working Group			
The Commanding General Marine Corps Combat Development Command established the USMC Urban Working Group to address internal USMC urban related issues and requirements. A coordination body, it currently performs those tasks associated with advocacy, coordination, deconfliction, collaboration and connectivity.			
Dates:	began FY98	**Cost:**	
Outlook:	Near/Mid/Far-term	**Focus:**	
Sponsor:	Marine Corps		
POC/More Information:	Maj Chris Castelli		

Project Battalion Staff Urban Planning and Considerations Wargame			
This ongoing wargame is designed to force battalion staffs to consider the unusual and unique considerations when engaged in or planning urban operations.			
Dates:	began 2QFY01	**Cost:**	
Outlook:	Near-term	**Focus:**	USECT/DOTMdLPCon
Sponsor:	Marine Corps		
POC/More Information:	Maj. J.S. Sauer, sauerj@mcwl.quantico.usmc.mil		

Project Metropolis (ProMet)

This effort was a follow on to the Urban Warrior program. Platoon, company, and battalion phases were conducted with the goal of improving tactics and equipment. ProMet's Tactical Experiment (2QFY01) was conducted with strategic and operational inputs from the earlier Project Lincolnia. Several sub-efforts were nested within ProMet.

- The Aircraft Susceptibility Experiment explored rotary-wing aircraft survivability issues in urban terrain.
- The Urban Ground Reconnaissance Development effort looks at improving ground reconnaissance in urban terrain. A company level experiment is planned for 1QFY02.
- The Basic Urban Skills Training (BUST) Package was developed from lessons learned in ProMet.
- The BUST Package (released 3QFY00) is a 100-hour course of instruction, with a combined arms emphasis, and is intended to teach the basic skills needed for all marines involved in MOUT. Experimentation determined that up to 70% of the casualties suffered were a direct result of a lack of familiarity with the urban environment and that loss rate can be overcome with better and more focused training.
- The ProMet Basic Essential Skills Testing (1QFY01) effort explored which basic urban skills degrade most rapidly and thus require retraining more frequently.

Additionally, ProMet explored: urban close air support, urban air assault, combined arms formations and tactics, and combat service support techniques. The ProMet effort was greatly facilitated by the availability of the former George Air Force Base for training. This facility, at minimal cost, allowed regimental size units to conduct combined arms training with unmatched realism. One Marine officer described George Air Force Base as the second best place in the world, after Grozny, to practice dealing with urban rubble.

Dates:	3QFY99-2QFY01	**Cost:**	
Outlook:	Near-term	**Focus:**	SE/DOTMdLPMsCon
Sponsor:	Marine Corps		
POC/More Information:	Mr. Dave Firestone, firestoned@mcwl.quantico.usmc.mil		

Small Unit Logistics ACTD

The goal of this program is to facilitate the creation of a CSS system that is better suited for the highly mobile and dispersed battlefield of the future. Central to "CSS of the Future" is a fully integrated, anticipatory CSS Command and Coordination system. Logistical operations will need to be thoroughly and rapidly planned, tightly controlled, and deliver supplies and services precisely. This ACTD will develop, in a web-based environment, a logistics support and information system that meets these needs.

Dates:	FY99-FY02	**Cost:**	$1.8 million (FY99-FY01)
Outlook:	Near-term	**Focus:**	S/MdCon
Sponsor:	Marine Corps		
POC/More Information:	Ms. Lynn Torres, torres1@mcwl.quantico.usmc.mil		

Small-Unit Remote Scouting System (SURSS) [Proposed]			
Small units, as low as the platoon level, would benefit from their own organic reconnaissance assets. The goal would be to allow these smaller units to observer and engage the enemy within range of their own organic weapons, beyond line of sight. This capability should apply to all terrain types, in real-time, 24 hours a day, and without risk to Blue personnel. Some of the envisioned characteristics of this system would be: a minimal logistical footprint, a minimal impact on the small units mobility, a range of at least 10km, be able to engage in missions of a least one hour, move through the battlespace at 20-45mph, be launchable from an airborne platform, and a low procurement cost.			
Dates:	FY02-FY06?	**Cost:**	
Outlook:	Mid-term	**Focus:**	U/M
Sponsor:	USMC		
POC/More Information:			

Urban Combined Arms Exercise [Proposed]			
This effort would apply lessons learned from Project Metropolis free-play urban experimentation to the full spectrum of MAGTF firepower in a live fire environment. The goal is to ascertain effective tactics, techniques and procedures for employment of combined arms in the urban environment in support of a maneuvering Ground Combat Element.			
Dates:	FY01?	**Cost:**	$600K
Outlook:	Near-term	**Focus:**	S/TCon
Sponsor:	USMC		
POC/More Information:			

Urban Generic Information Requirements Handbook (GIRH)			
The Marine Corps Intelligence Activity produced this handbook. The handbook assists expeditionary forces engaged in MOUT with time-sensitive and crisis planning. It has become a popular urban information guide for service and joint staffs, both at the tactical and operational levels.			
Dates:	published 1QFY99	**Cost:**	
Outlook:	Near-term	**Focus:**	U/D
Sponsor:	Marine Corps		
POC/More Information:	Ms. Dana Harmon at MCIA		

Urban Generic Information Requirements Handbook (GIRH) Rewrite			
This effort is focused on incorporating the lessons learned from recent urban operations and experimentation into an updated Urban GIRH. This rewrite will also tie into the doctrinal IPB products outlined in FM 34-1-30 *Intelligence Preparation of the Battlefield.*			
Dates:	1QFY01-3QFY01	**Cost:**	
Outlook:	Near-term	**Focus:**	U/D
Sponsor:	Marine Corps		
POC/More Information:	Captain Erwin Dick, edick@nmic.navy.mil		

Urban Reconnaissance Development Program [Proposed]			
This effort would seek ways to solve the deficiencies in obtaining and disseminating useful and timely reconnaissance information in the urban environment at the tactical level. The Rand Corporation would participate in this program.			
Dates:	~2QFY01-4QFY02	**Cost:**	$500K
Outlook:	Near-term	**Focus:**	U/TCon
Sponsor:	USMC		
POC/More Information:			

Urban Warrior			
Urban Warrior was conducted over a two-year period and concluded with an Advanced Warfighting Experiment (AWE) in 2QFY99. This series of experiments focused on developing tactics, techniques and procedures (TTPs) as well as equipment and technology enhancements that could be incorporated, where feasible, to improve the Marine Corps' urban operating capabilities. However, the AWE was unable to achieve better than a 34 percent average friendly casualty rate. For this reason the MCWL decided to continue its MOUT experimentation with the Urban Warrior follow-on Project Metropolis.			
Dates:	FY97-FY99	**Cost:**	$47.2 million
Outlook:	Near-term	**Focus:**	SE/DTMdLPMsCon
Sponsor:	Marine Corps		
POC/More Information:			

Yuma Range Urban Training Complex (Yodaville)			
Yodaville was designed and built to provide a realistic simulation of an urban environment for live fire air support activities. To save costs, a unit based at Marine Corps Air Station Yuma built the target set. Various large cargo containers were used to represent buildings. The complex is currently composed of: 178 "buildings" (maximum height 35'), 31 vehicles, 22 streets, 2 parking lots, 1 soccer field, 120 personnel targets (mix of Blue/Red/White), 12 streetlights, and 5 Forward Air Controller Outposts. The range is scorable using both the visual Weapons Impact Scoring System and the TACTS-based No Drop Bomb Scoring System. Upgrades are being added to increase the realism of the targets including more vehicle targets and moving targets. Completion of these upgrades is expected by 3QFY01. Control and management of the range has been passed to Yuma Range Facilities.			
Dates:	construction phase 4QFY98-4QFY99	**Cost:**	$1.06 million
Outlook:	Near-term	**Focus:**	E/T
Sponsor:	Marine Corps		
POC/More Information:			

US Navy

Blast Fragmentation Hellfire II			
The AGM-114M (blast fragmentation Hellfire II) is similar to the AGM-114K anti-armor Hellfire II in all respects except the warhead. Lockheed Martin developed the AGM-114M based on interest from the Navy in increasing Hellfire lethality against maritime and urban target sets. The existing AGM-114B/K was very effective against heavily armored targets (e.g., main battle tanks), but proved limited in its capability versus softer targets like structures and boats. Follow on PGM requirements from the Navy will direct work toward development of a dual use warhead combining both shaped charge and blast fragmentation capabilities.			
Dates:	1QFY98-delivery expected 3QFY01	**Cost:**	$65K/missile, initial buy of 100
Outlook:	Near-term	**Focus:**	E/Md
Sponsor:	Navy		
POC/More Information:			

Extending the Littoral Battlespace (ELB) ACTD			
This effort looks at the operational level. The aim is to improve capabilities across all types of terrain in the littoral battlespace, including urban areas. By exploiting the potential of mature and emergent technologies capabilities can be provided that would allow theater-wide situational awareness, sensor networks, effective remote fires and a robust interconnected information infrastructure. Improvements will be sought in the areas of information superiority, precision engagement, dominant maneuver, and focused logistics. A Major System Demonstration (MSD) was conducted during Operation Kernel Blitz 99. The proof-of-principle was successfully demonstrated, using off-the-shelf technologies to create an over-the-horizon, high bandwidth, tactical information and data network. Subsequent activities included an initial military utility assessment and a determination of interim residual and/or transition opportunities. FY00 plans were to refine the MSD I architecture and technology enhancements and to participate in two Limited Objective Experiments (LOEs) with operating forces in preparation for MSD II in FY 2001. A MSD II is to be conducted in 2QFY01, followed by a rapid military utility assessment and potential transition to acquisition of accepted residual systems.			
Dates:	2QFY97-FY02	**Cost:**	$20.0 million (FY99-FY01)
Outlook:	Near/Mid-term	**Focus:**	U/Md
Sponsor:	Navy		
POC/More Information:	Mr. Ray Cole, coler@onr.navy.mil		

Naval War College Urban Operations Course			
This elective course has two stated objectives. The first is to further the education of military officers in the study of urban warfare at the tactical, operational, and strategic levels of war. The second objective is to produce leaders with the mental flexibility to solve complex problems in peace, conflict, and war in an urban environment.			
Dates:	began 2QFY01	**Cost:**	
Outlook:	Near/Mid/Far-term	**Focus:**	/L
Sponsor:	Navy		
POC/More Information:			

Defense Advanced Research Projects Agency

Advanced Consequence Management			
This program sees the central problem in consequence management as the tie in between people, resources, and software components. This requires the training of personnel, establishing predetermined requirements, and identifying resources available within a community. There are two key components. The Incident Command Management System allows the Incident Commander to maintain better control and situational understanding of the scene. The Patient Management Information System monitors the health of personnel and gives early warning when various substances are encounter. Both components have been tested in exercises and further testing and evaluation is planned at academic and Federal laboratories.			
Dates:	began ~FY99	**Cost:**	
Outlook:	Mid-term	**Focus:**	C/TMd
Sponsor:	DARPA		
POC/More Information:	LCDR Kurt A. Henry, M.D., USN, khenry@darpa.mil		

Alternatives to Antipersonnel Landmines			
DARPA is developing technologies that provide alternatives to antipersonnel landmines (APLs) under this project. The systems developed will provide the warfighter with enhanced capabilities that obviate the need for APL. Technologies include self- healing antitank (AT) minefields (that allow the protection of AT mines without the use of APL) and tags with minimally guided munitions that allow the compression of critical timelines and distances constraints imposed by conventional indirect and direct fire approaches.			
Dates:	FY99-FY01	**Cost:**	$28.0 million (FY99-FY01)
Outlook:	Mid-term	**Focus:**	S/Md
Sponsor:	DARPA		
POC/More Information:	Dr. Tom Altshuler, SHM@darpa.mil		

Battlefield Awareness and Data Dissemination ACTD (BADD)			
A DARPA effort aimed at improving situational awareness and communications theater-wide. The BADD software package was delivered to PACOM for operational utility assessment. As of 2QFY00 the plan was to field BADD to selected CinCs in 3QFY00. The goal is to develop, install, and evaluate an operational system that allows commanders to design their own information system; one that delivers to warfighters an accurate, timely, and consistent picture of the Joint/coalition battlefield; and provides access to key transmission mechanisms and worldwide data repositories.			
Dates:	1QFY96-FY00	**Cost:**	$65.7 million (FY98-FY00)
Outlook:	Near-term	**Focus:**	US/Md
Sponsor:	DARPA		
POC/More Information:	Mr. Thomas Perdue, perduet@acq.osd.mil		

Human ID at a Distance			
This program's aim is to develop automated multi-modal surveillance technology for identifying humans at a distance to provide protection and early warning against the Asymmetric Threat. The goals of the program are to identify humans, using multiple biometric modes, at a distance of up to 500 feet. Furthermore, the system would operate at all times, day or night, during all weather conditions, with a probability of correct identification of 0.99, a probability of false alarms of 10^{-3} and a gallery size up to 10^{6}. Identification would be possible on non-cooperative subjects, possibly in disguise, alone or in groups, and automatically create folders for collecting data on repeat visitors.			
Dates:	4QFY00-FY04	**Cost:**	
Outlook:	Mid-term	**Focus:**	U/Md
Sponsor:	DARPA		
POC/More Information:	Dr. Jonathon Phillips, jphillips@darpa.mil		

Command Post of the Future (CPOF)			
A DARPA effort at developing technologies and designs for future command posts. The goal of CPOF is to double the speed and quality of command decisions while reducing the staff by one half. To achieve this operational goal, the technical objective is to develop the technology necessary to create an adaptive, decision-centered, information visualization environment for the future commander and his immediate staff.			
Dates:	FY98-FY02	**Cost:**	$54.3 million (FY98-FY01)
Outlook:	Mid-term	**Focus:**	US/OMdL
Sponsor:	DARPA		
POC/More Information:			

Dog's Nose/Unexploded Ordnance (UXO)Detection Program			
The Dog's Nose/ Unexploded Ordnance (UXO) Detection program will develop sensors for the chemically specific detection of explosives or other chemicals characteristic of land mines and/or shallowly buried UXOs. The sensors developed under this program will provide soldiers with the effectiveness of canine olfaction detection without the logistics and other constraints imposed by the use of live animals. These chemically specific sensors will work either singly or in conjunction with other technologies such as the hyperspectral mine detector, developed under the Small Unit Operations (SUO) program that exploit different physical features.			
Dates:	began FY97	**Cost:**	$25.5 million (FY98-FY99)
Outlook:	Near-term	**Focus:**	S/Md
Sponsor:	DARPA		
POC/More Information:	Dr. Thomas W. Altshuler, taltshuler@darpa.mil		

Exoskeletons for Human Performance Augmentation			
The goal of this program is to increase the speed, strength, and endurance of soldiers in combat environments. Technologies will be developed, such as actively controlled exoskeletons, to enable a soldier to handle more fire-power, wear more ballistic protection, and carry more ammunition and supplies. This would increase the lethality and survivability of ground forces in all combat environments, especially for soldiers in urban terrain. Systems with varying degrees of sophistication may be explored from an unpowered mechanical apparatus to full-powered mechanical suits. One of the critical issues for exoskeletons is power for actuation. This program worked on developing efficient, integrated power and actuation components to generate systems with duration that are operationally significant. Researchers explored the use of chemical/hydrocarbon fuels (with very high energy density and specific energy) for the mechanical actuation (as opposed to other energy storage media, e.g., batteries, compressed air, etc.) with varying degrees of sophistication. An understanding of biomechanics, feedback, and control are also critical to the building of an integrated system.			
Dates:	4QFY99-3QFY00	**Cost:**	
Outlook:	Far-term	**Focus:**	S/Md
Sponsor:	DARPA		
POC/More Information:	Dr. Ephrahim Garcia, egarcia@darpa.mil		

Low-Power Radio Frequency Electronics			
Man-portable communications and advanced airborne and space-based platforms are severely limited in volume and weight. In addition, the demands for wider bandwidth, higher stability, and increased functionality are challenging available technology. New lower power RF devices and components are needed to improve sensitivity and selectivity with reduced noise, while minimizing power consumption in planned and ongoing communications and sensor-based systems. This effort encompasses design, fabrication, and simulation of device structures, circuits, and materials for power-efficient RF electronics, high-power added-efficiency amplifiers and sources, ultra stable frequency control oscillators and clocks, miniaturized low-loss filters and microresonators, circulators, and enhanced component thermal management technologies.			
Dates:	FY97-FY99	**Cost:**	$23.8 million (FY97-FY99)
Outlook:	Mid-term	**Focus:**	S/Md
Sponsor:	DARPA		
POC/More Information:	Dr. K. Gabriel, (DARPA), (703) 696-2252		

Metal Storm			
This program is aimed at developing a radical new firing system for both small arms and larger ship/vehicle mounted systems. The new design is an all-electric firing system requiring no firing pin, no explosive primer, and no mechanical ammunition-feeding mechanism. The electronic system uses just propellant and projectiles packed on top of each other in canister-shaped firing tubes. Prototypes have demonstrated extremely high rates of fire (x10+ vs. current small arms). Weapons using this design would feature disposable block reloading: when a barrel is empty it would be discarded and a loaded one locked into place. Some of the potential uses are: an area denial and mine-field replacement pod, a close-in weapons system for ship and vehicle defense, a gun pod for robotic vehicles (ground or air), and smalls arms that could be loaded with lethal and non-lethal munitions simultaneously.			
Dates:	2QFY00-FY02	**Cost:**	$10.6 million (FY00-FY02)
Outlook:	Mid-term	**Focus:**	E/Md
Sponsor:	DARPA		
POC/More Information:	Dr. Mike Mattice, mmattice@darpa.mil		

Mobile Autonomous Robot Software (MARS) Project			
The Mobile Autonomous Robot Software (MARS) project seeks to develop and transition the missing software technologies needed to program the autonomous operation of singly autonomous, mobile robots in partially known, changing, and unpredictable environments. These autonomous systems will not have to rely on synchronous command inputs from a remote human operator, nor depend upon high quality, real-time/near real-time data link connectivity, which often cannot be guaranteed. The key idea is to extend robot learning and control ideas, including soft computing, robot shaping, and imitation, as well as other situated, embodied, and interactive software development approaches in order to revolutionize both the programming and utility of autonomous mobile robots. These robotics will serve to reduce the cost to acquire and sustain military systems, extend the range of military hardware capabilities, and radically change how we think about and design, build, and employ future military systems. This project will capitalize on the progress made elsewhere in various mechatronic and information sciences.			
Dates:	4QFY99-FY01?	**Cost:**	
Outlook:	Mid-term	**Focus:**	U/Md
Sponsor:	DARPA		
POC/More Information:	Dr. Douglas Gage, dgage@darpa.mil		

Micro Air Vehicles			
In this program a new family of Micro-Air Vehicles (MAVs) that are at least an order of magnitude smaller than current flying systems (less than 15 cm in any dimension) will be developed and demonstrated. The capability to accomplish unique military missions as diverse as covert imaging in constrained areas, biological-chemical agent detection and characterization, remote precision mines, and urban battlefield communications enhancement, will be stressed through an examination of a variety of vehicle concepts. The resulting capability should be especially beneficial in the emerging urban warfighting environment, characterized by its complex topologies, confined spaces and areas (often internal to buildings), and high civilian concentrations. The MAV program will focus on the technologies and components required to enable flight at these small scales, including flight control, propulsion and lightweight power, navigation and communications. These will build upon and exploit numerous DARPA technology development efforts, including advanced communications and information systems, high performance computer technology, Microelectro-mechanical Systems (MEMS), advanced sensors, lightweight, efficient high density power sources, and advanced electronic packaging technologies.			
Dates:	FY98-FY01	**Cost:**	$43.3 million (FY98-FY01)
Outlook:	Mid/Far-term	**Focus:**	U/Md
Sponsor:	DARPA		
POC/More Information:			

MicroElectroMechanical Systems (MEMS)

This project is a broad and cross-disciplinary initiative to develop an enabling technology that merges computation with sensing and actuation to realize new systems for both perceiving and controlling weapons systems, processes and battlefield environments. Using fabrication processes and materials similar to those that are used to make microelectronic devices, MEMS conveys the advantages of miniaturization, multiple components and integrated microelectronics to the design and construction of integrated electromechanical systems. Within MEMS are several subprograms.

- The Distributed Robotics Program seeks to develop revolutionary approaches to extremely small robots, reconfigurable robots, systems of robots, biologically-inspired designs, innovative methods of robot control including innovative interfaces, and methods of implementing pooled capabilities and/or layered intelligence. The program focus is upon individual robots that are less than 5 centimeters in any dimension; however, novel methods of long-range deployment may involve larger transport vessels. Potential applications for such robots or systems of robots include surveillance, reconnaissance, path finding, deception, weapon delivery, transporting artifacts, and small-scale actuation. Applications might include minefield detection wherein small sensors are mounted on hopping robots or robots with multi-task capabilities, intelligence gathering in city pipelines, robots used in large numbers for decoy applications, or extremely small robots that might be injected and pick a door lock.
- The Smart Dust Project focus is creating massively distributed sensor networks. The sensor networks will consist of hundreds to thousands of sensor nodes, and one or more interrogators to query the network and read out sensor data. The sensor nodes will be completely autonomous, and quite small. Each node will contain a sensor, electronics, power supply, and communication hardware, all in a cubic millimeter volume. The goals of this project are to explore the fundamental limits to the size of autonomous sensor platforms, and the new applications that become possible when autonomous sensors can be made on a millimeter size scale. An example would be sensor nodes so small they float in the air like dust. Some of the accomplished milestones in this project include: demonstrated laser communication from a 1 cubic inch weather station at a distance of 21km, demonstrated silicon dandelion and maple seeds which nearly float in air, and setting a flight duration record for a micro air vehicle (18+ minutes).

Dates:	FY98-FY05	**Cost:**	$147.4 million (FY98-99) $496.8 million (FY00-05)
Outlook:	Mid/Far-term	**Focus:**	U/Md
Sponsor:	DARPA		
POC/More Information:	Dr. William Tang, wtang@darpa.mil		

Personnel Protection			
The performance of body armor systems against 7.62 mm (30 caliber) armor piercing ammunition has steadily improved due to the use of new ceramic materials and fibers and advances in the synthesis and processing of new armor materials. Nevertheless, a soldier using state-of-the-art body armor would need to wear more than six pounds per square foot of the material in order to stop such a bullet, a load too heavy for effective movement in the field. Unfortunately, significant gains can no longer be made through simple changes in processing techniques or in materials substitution. To spur a breakthrough in body armor performance, DARPA began a program that employs rigorous models and simulations to develop innovative materials/systems designs. The performance goal is to stop a 7.62-mm armor piercing round with 3.5 pounds per square foot of armor. Several promising avenues are being explored in a second phase of this program, including an active armor approach.			
Dates:	FY98-FY01	**Cost:**	
Outlook:	Mid-term	**Focus:**	S/Md
Sponsor:	DARPA		
POC/More Information:	Dr. Steven G. Wax, swax@darpa.mil		

Small Unit Operations (SUO)

The objective of the Small Unit Operations Program is to develop critical technologies that will enable small dismounted forces to effectively fight anywhere, anytime. The technology needs are: semi- automated maneuver and strike/ fire planning and re-planning that can be employed by commanders who are physically separated but need to be virtually collocated; automated fusion and mining of information sources to provide a "bubble" of awareness over each warrior and team describing the relevant situation; accurate geographic position estimation, other than GPS, which works in all environments; and radio links and ad hoc networked communications that "glue" the components together, operates in any environment, is covert and is resistant to interference. In addition, these technologies must not significantly increase the dismounted force's mass and power burden.

Within SUO are four elements: the Situational Awareness System, the Geolocation Technology Program, the Tactical Sensors Program, and the Laser Acoustic Sensors Program.

- The Situation Awareness System (SAS) will integrate these technologies into a 1 kg module (plus 0.5 kg per day for the power source) worn by the individual warrior. The DARPA module will be interoperable with the Army Land Warrior equipment and provide much greater functionality at significantly less weight. The warrior module will provide the communications and computing power to fully interconnect the dismounted force and enable situation awareness information to be distributed, as well as support continuous planning and combat execution.
- The Geolocation Technology Program will develop and demonstrate precision miniature clocks, a low- power Global Positioning System (GPS) receiver/ processor (2 joules per fix) and a digital LORAN receiver to provide the accurate navigation and targeting needed for small unit operations.
- The Tactical Sensors program will develop new sensor system technologies that will provide the warfighter with a capability to detect, track, and classify mobile tactical targets and to characterize fixed, man- made structures. These sensor systems provide a local, in-situ sensing capability near high value targets or at choke points in denied areas. Information provided by these sensors can be fused with other longer-range space, airborne, and ground sensor systems to enhance the aggregate surveillance and tracking capabilities of US forces. Applications include surveillance, cueing, precision targeting, intelligence, and battle damage assessment with respect to time critical, mobile targets (vehicles and humans) and to fixed, man- made structures (surface and underground facilities).
- The Laser Acoustic Sensors program will develop a completely new class of laser acoustic sensors for military surveillance and targeting applications. These sensors will provide surveillance, target detection, tracking, classification, cueing, and bomb damage assessments at distances 10X greater than current capabilities. The acoustic sensor will use a virtual acoustic array generated by angle scanning and range gating a laser beam in the atmosphere. Natural aerosols in the virtual array are displaced by the acoustic pressure wave generated by the target, and thus provide a phase modulated backscatter of the laser energy that is detectable by the receiver. A recent breakthrough in defining atmospheric turbulence cells with unique, fine structure doppler spectrum permits visibility and access to the target acoustic signature sideband structure.

Dates:	1QFY96-FY05	**Cost:**	$181.4 million (FY98-FY01), $223.5 million (FY02-FY05)
Outlook:	Mid-term	**Focus:**	US/Md
Sponsor:	DARPA		
POC/More Information:	Dr. Paul Kolodzy, pkolodzy@darpa.mil		

Smart Sensor Web			
Smart Sensor Web is a sweeping effort involving the individual services, DARPA, SOCOM, JFCOM, various universities and others. The project is designed to ensure that battlefield sensors of all kinds form an intelligent web that spans the battlefield, making critical wartime data available to individual soldiers from one Web site, which could be accessed via a wearable computer, a personal digital assistant, a laptop or another available computer. The Pentagon initiated the project after doing an inventory of the research being conducted across services and agencies. DoD officials found that research was often unique to individual commands or agencies, and with a moderate level of effort those efforts could be linked to generate synergistic benefits.			
Dates:	FY00-FY02	**Cost:**	
Outlook:	Mid-term	**Focus:**	U/Md
Sponsor:	DARPA		
POC/More Information:			

Tactical Mobile Robotics (TMR)			
A DARPA effort aimed at the tactical level. Its goal is to develop semi-autonomous robotic platforms capable of penetrating denied terrain of a complex nature.			
Dates:	FY99-FY01	**Cost:**	
Outlook:	Mid-term	**Focus:**	U/Md
Sponsor:	DARPA		
POC/More Information:			

Intelligence Community

Defense Intelligence Agency's Intelligence Support to Urban Operations Conference After-Action Report			
Conference participants agreed that there must be a concerted unity of effort in the IC regarding collection and production of urban intelligence. Most participants saw duplication of effort among all agencies' urban efforts. Several recommended the creation of an IC Urban Working Group to define lanes in the road, exchange data and create product standards. There was also a desire expressed for a single comprehensive urban intelligence product.			
Dates:	FY99	**Cost:**	
Outlook:	Near-term	**Focus:**	U/O
Sponsor:	IC		
POC/More Information:			

Defense Intelligence Agency, Military Operations in Built-up Areas (DIA MOBA)			
DIA MOBA was a 1998 Intelligence Program Review Group (IPRG) initiative that provided funding to DIA to produce a proof-of-concept of a web-based, geo-referenced urban visualization tool that provided seamless access to multiple databases. MOBA was terminated at the two-year mark in an anticipated five-year program.			
Dates:	4QFY98-4QFY00	**Cost:**	
Outlook:	Mid-term	**Focus:**	U/Md
Sponsor:	IC		
POC/More Information:			

Defense Intelligence Urban Operations Working Group (DIUOWG)			
The Assistant Secretary of Defense (C^3I) established the DIUOWG to address Defense Planning Guidance, which highlighted the need to better integrate MOUT efforts across DOD. The focal point for addressing DOD urban intelligence shortcomings identified in the GAO report on Urban Capabilities, the DIUOWG is currently developing an Urban Intelligence Roadmap in support of the overall DOD roadmap effort. Other DIUOWG efforts include those tasks associated with the working group's role as the DOD focal point for urban intelligence advocacy, coordination, deconfliction, collaboration and connectivity.			
Dates:	stood up 3QFY00	**Cost:**	
Outlook:	Near-term	**Focus:**	U/
Sponsor:	IC		
POC/More Information:	Mr. Ken Parr (703) 695-4224 or Mr. Dave Dilegge (703) 684-2352		

How They Fight — Issue on MOUT			
The National Ground Intelligence Center (NGIC) publishes the *How They Fight* series quarterly on a range of topics relating to foreign military capabilities. The August 2001 issue was a special one focusing on MOUT. The topics addressed included: Chinese urban doctrine, the siege of Sarajevo, MOUT deception and denial, Russian snipers in Chechnya, mines and booby traps in Chechnya, MOUT training facilities, short-range ballistic missiles in MOUT, and foreign sniper detection systems.			
Dates:	4QFY01	**Cost:**	
Outlook:	Near-term	**Focus:**	US/L
Sponsor:	IC		
POC/More Information:	Project Manager: Michael J Dueweke, NGIC, 2055 Boulders Road, Charlottesville, VA 22911-8318.		

HUMINT and Counterintelligence Support Tools			
This DIA program's goal will be to improve the timeliness and accuracy of HUMINT and CI targeting, collection and dissemination. The focus will be on targeting, collection and dissemination technology, tools and systems to support strategic, operational and tactical HUMINT and CI. Preference will be given to modification, adaptation, and integration of existing capabilities versus development of new technology. FY01 plans are to: assess CONOPS, equipment and architecture in a Joint Warfighting exercise, and conduct OCONUS real-world military utility assessment and operational evaluation.			
Dates:	FY99-FY03	**Cost:**	$4.9 million (FY99-FY01)
Outlook:	Near-term	**Focus:**	U/Md
Sponsor:	IC		
POC/More Information:	Maj. Marylee Cole, coleml1@gte.net		

Integrated Collection Management (ICM) ACTD			
The goal of this ACTD is to demonstrate the military utility of providing the tactical commanders with the ability to see what higher echelon shared assets are tasked and scheduled to collect and, at times, control collection efforts and synchronize with their operational plans. By enabling integrated tasking of a wide range of collection systems CinCs, Joint Force Commanders, and their component commanders will be able to deal with time-critical targets and force protection. Fiscal year 2001 plans were to develop additional interfaces to collection platforms, collection nodes and data sources, further enhance and refine software, develop systems integration and enhancements to processes in response to tactical feedback, conduct a final military utility assessment demonstration, deliver residual interim capability to JFCOM, and begin transition of technology for acquisition.			
Dates:	3QFY97-FY03	**Cost:**	$5.5 million (FY99-FY01)
Outlook:	Near-term	**Focus:**	U/OMdL
Sponsor:	IC		
POC/More Information:	CDR Stan Stafersky, (757)836-0271		

National Ground Intelligence Center/Marine Corps Intelligence Activity Joint Urban Task Force (NGIC/MCIA Joint Urban Task Force)			
In 3QFY00 the NGIC was named the Executive Agent (EA) for urban operations related intelligence production by the Department of Defense Intelligence Production Program (DODIPP). A caveat to this designation was that NGIC fully engage MCIA as a partner. As a result, NGIC and MCIA stood up the Urban Operations Intelligence Task Force and are in the formative stages of defining and producing products related to Urban Intelligence Preparation of the Battlefield (IPB). NGIC provides scientific and technical intelligence (S&TI) and general military intelligence (GMI) on foreign ground forces. NGIC has also shown interest in the Defense Intelligence Agency's (DIA) Military Operations in Built-up Areas (MOBA) program. DIA MOBA was a 1998 Intelligence Program Review Group (IPRG) initiative that provided funding to DIA to produce a proof-of-concept of a web-based, geo-referenced urban visualization tool that provided seamless access to multiple databases. DIA terminated DIA MOBA at the two-year mark in an anticipated five-year program. MCIA produces a full range of products to satisfy customer needs in peace, pre-crisis, or contingency situations, and to support service obligations for doctrine development, force structure, training and education, and force modernization. MCIA accomplishes this mission through the integration, development, and application of general military intelligence, technical information, all source production, and open-source materials. MCIA has been a leader in urban battlefield visualization technologies. MCIA also produced the Urban Generic Information Requirements Handbook and is in the early stages of producing a Cultural Intelligence (Complex Human Environments) Handbook.			
Dates:	3QFY00	**Cost:**	
Outlook:	Near-term	**Focus:**	US/
Sponsor:	IC		
POC/More Information:			

National Imagery and Mapping Agency Urban Geospatial Information Program (NIMA)			
The Urban Geospatial Information Roadmap effort has prototyped five levels of maps with information that builds upon a base image map capable of densifying up through existing city maps. Level-five addresses three-dimensional urban site models. This program will enable the rapid production of level-one (base image maps) for readiness and planning and be capable of surge (densify) through levels two-five as required. The program started 4QFY98 and Image City Maps of Kosovo were provided in 3QFY99. Geospatial prototypes were produced 3QFY00 with service approval 1QFY01. The FY 01 NIMA production plan that includes new Image City Maps has been approved.			
Dates:	4QFY98 +	**Cost:**	
Outlook:	Near-term	**Focus:**	U/MdMs
Sponsor:	IC		
POC/More Information:			

Urban Intelligence Preparation of the Battlefield ACTD (Urban IPB ACTD) [Proposed]			
An intelligence community effort that would aim at the operational level, may be scheduled for FY02-FY05.			
Dates:	FY02-FY05	**Cost:**	
Outlook:	Near-term	**Focus:**	U
Sponsor:	IC		
POC/More Information:			

Urban Intelligence Conference			
The conference, held at the National Ground Intelligence Center (NGIC), focused on threat capabilities in MOUT out to 2015. Briefings were given by NGIC staff on: urban IPB, infantry weapons, thermobaric weapons, the lessons of Grozny, GPS jammers, urban RSTA, obscurants, PLA preparations for MOUT, RF weapons, armored vehicles in MOUT, laser blinders, UAVs, attack helicopters, hybridization of weapons for MOUT, chemical weapons, consequence assessment, and the threats to individual soldiers.			
Dates:	4QFY01	Cost:	
Outlook:	Near/Mid/Far-term	**Focus:**	USEC/L
Sponsor:	IC		
POC/More Information:	Dr. Robert O'Connell, NGIC, 2055 Boulders Road, Charlottesville, VA 22911-8318.		

Joint

Advanced Focal Plane Array Technology			
This Science and Technology Objective's goal was to develop and mature components for a more advanced generation of IR imaging sensors that take advantage of advanced large staring focal plane arrays that allow smart temporal and multispectral signal processing. One envisioned use for this technology is soldier vision enhancement.			
Dates:	FY00-FY02?	**Cost:**	$37.8 million (FY00-FY02)
Outlook:	Mid-term	**Focus:**	U/Md
Sponsor:	Army/Navy		
POC/More Information:	Dr. Susan Turnbach, USD (A&T)		

Aircraft Susceptibility Experiment [Proposed]			
This effort would further explore the feasible of conducting rotary wing operations during daylight hours in the urban battlespace. The proposed timeframe is 1QFY02 and the envisioned location would be the former George Air Force Base.			
Dates:	1QFY02	**Cost:**	
Outlook:	Near-term	**Focus:**	S/Con
Sponsor:	Marine Corps/Army		
POC/More Information:			

Beyond Jointness Conference

A conference examining the civil-military dimensions of Peace Operations was held 2-3 June, 1999. Hosted by the Institute for National Strategic Studies, National Defense University, it built on a previous conference entitled "The Civil Dimensions of Military Operations" held at NDU on 23-24 September 1998. The 1999 conference was attended by over 100 scholars, military officer, and experienced practitioners from governmental and non-governmental organizations. They split into three groups to address three areas of concern identified in the 1998 conference:

- civil-military unity of effort,
- education of military commanders about the challenges of operating with NGOs (and civilians about military activities), and
- the availability of resources to meet special demands.

The 1999 conference strengthened the purpose of the Contingency Planning Interagency Working Group (part of the PDD-56 process), and provided momentum to the efforts developing Annex V of regional Operations Plans. Recommendations emerging from the conference included:

- institutionalizing a cadre of experienced specialists to assist the NSC and Interagency community with the development of political-military plans,
- establishing a Civil-Military Affairs Advisor in each combatant command,
- establishing PME and training programs to educate both military, Interagency, and IO/NGO communities, and
- reexamining the Reserve Component structure to increase civil-military expertise within active duty organizations.

Dates:	3QFY99	**Cost:**	
Outlook:	Near-term	**Focus:**	T/
Sponsor:	Joint Staff		
POC/More Information:			

En Route Mission Planning & Rehearsal (EMPRS) ACTD			
The en route mission planning and rehearsal system (EMPRS) will update and maintain joint situational awareness by establishing real-time, in-transit communications between ground command and deployed airborne units. The system, which is scheduled to be tested as part of the September 2000 joint contingency force advanced warfighting experiment (JCFAWE) while on the move between Fort Bragg, North Carolina, and Fort Polk, Louisiana, is one of the latest products in the search for versatility in comprehensive operations communication. It will act as a platform for three-way communications between mission command headquarters, a task force en route and a site of operations. The system also will provide command and control to deploying forces by enabling headquarters to plan and replan operations collaboratively based on changes to the operational scenario.			
Dates:	FY00-FY07	**Cost:**	$196 million (FY02-FY07)
Outlook:	Near-term	**Focus:**	U/Md
Sponsor:	JFCOM		
POC/More Information:	LTC Robert Morris, morrisr@benning.army.mil		

Handbook for Joint Urban Operations			
This document is a primer on joint urban operations. It is intended to provide joint force commanders, their staffs, and other interested parties with fundamental principles and operational-level considerations for the conduct of joint urban operations. While it is consistent with joint and Service doctrine it is not a doctrinal publication. The Handbook is intended to inform, rather than dictate, the actions of joint forces conducting urban operations.			
Dates:	3QFY00	**Cost:**	$250K
Outlook:	Near-term	**Focus:**	USECT/DOTMdLPMsCon
Sponsor:	Joint Staff/Air Force		
POC/More Information:	Joint Staff, J-8, (703)-695-4657		

Individual Combatant and Small-Unit Operations Simulation			
This DTO will develop a high-level, architecture-compliant individual combatant simulation system across the Research, Development and Acquisition (RDA), Advanced Concepts and Requirements (ACR) and Training Exercises and Military Operations (TEMO) domains. Technical barriers include human representation and visualization of individuals and weapon states, human performance modeling, human system interfaces that are unencumbered and elicit realistic performance, networked simulations for interoperability with other dissimilar simulations, computer-generated forces that contain realistic individual and unit-level behaviors with C3I representation, synthetic terrain with relevant resolution/fidelity to allow operations in a tactically correct manner, and instrumentation for high-precision engagement simulation to allow for data capture and analysis.			
Dates:	FY97-FY98	**Cost:**	$6.2 million (FY97-FY-98)
Outlook:	Near-term	**Focus:**	/Ms
Sponsor:	Army/Marine Corps		
POC/More Information:	Ms. Traci Jones (STRICOM), (407) 384-3927		

J2 Decision Support Center Urban Intelligence, Surveillance and Reconnaissance Study			
This study was conducted at the Secret classification level. An unclassified summary of this study found significant shortfalls in DoD's capability to provide quality urban intelligence. These shortfalls include urban intelligence/information collection, processing, analysis and dissemination. The study also outlined possible solutions to address these shortfalls.			
Dates:	Released 3QFY00	**Cost:**	
Outlook:	Near-term	**Focus:**	U/
Sponsor:	Joint Staff		
POC/More Information:			

J6 C^4I Study			
This study had four main goals: provide short term technology recommendations to provide interim capabilities to dismounted infantry, identify technologies that merit further exploration, define operational requirements for communications, and recommend changes to the Joint Tactical Radio System. The study also identified several problem areas in urban communications: tactical communications between infantry units and infantry units and air assets, reach-back communications, Army/USMC interoperability, and navigation and location.			
Dates:	released 1QFY00	**Cost:**	
Outlook:	Near-term	**Focus:**	US/
Sponsor:	Joint Staff		
POC/More Information:			

Joint Common Missile			
The Joint Common Missile (JCM) is currently in development by the Army. An MOU has been signed between the Army (lead service) and the Navy to cover concept exploration for a joint program. As currently envisioned, the JCM will replace both the TOW and Hellfire missile systems. The Navy also seeks to replace its Maverick missiles with the JCM, making it compatible with both fixed and rotary wing aviation. The primary target set for this weapon will be moving tactical targets. A requirement has also been levied on this weapon for increased effect against a broader target set to include bunkers, structures, artillery, C^2 sites, and other soft targets. Project Definition and Risk Reduction efforts are currently ongoing and the E&MD phase will begin 2QFY04.			
Dates:	1QFY01-FY08	**Cost:**	
Outlook:	Mid-term	**Focus:**	E/Md
Sponsor:	Army/Navy		
POC/More Information:			

Joint Conflict and Tactical Simulation (JCATS)			
A JFCOM sponsored modeling and simulation tool capable of depicting individual soldiers inside buildings. Version 1.0 was released 3QFY98 and version 2.0 was released 4QFY99. Improvements in JCATS were funded through the MOUT ACTD program.			
Dates:	first released 3QFY98	**Cost:**	
Outlook:	Near-term	**Focus:**	USE/TMsCon
Sponsor:	JFCOM		
POC/More Information:	Chris Christenson, wchriste@ida.org		

Joint Non-Lethal Weapons Program

This program was developed to provide warfighters a family of Non-Lethal Weapon (NLW) systems with a range of optional non-lethal capabilities across the full spectrum of threats and crisis. The program was Congressionally mandated in FY96 and is scheduled to run indefinitely. A NLW Joint Vision Study was conducted in 1999 to determine if, where, and how non-lethal weapons could contribute to future military operations. Nested within the JNLWP are numerous other efforts. Concept Exploration Programs have been initiated several of the eight NLW functional areas: 1) Area Denial to Personnel, 2) Crowd Control, 3) Clear Facilities, Structures & Areas, 4) Incapacitate Individuals or Groups, 5) Area Denial to Vehicles, Vessels, & Aircraft, 6) Disable or Neutralize Vehicles, Vessels, & Aircraft, 7) Disable or Neutralize Facilities and Systems, and 8) Deny the use of Weapons of Mass Destruction (WMD). Other efforts include developing and leveraging emerging technologies such as directed energy, lasers, anti-traction material, non-kinetic, and other technologies in counter personnel, counter-materiel, and counter-capability missions.

A Joint NLW Mission Area Analysis/Joint Mission Need Analysis was conducted in FY00 to explore the employment of non-lethal/non-kinetic technologies across the entire spectrum of operations. The JROC endorsed the results of the NLW JMAA/JMNA in May 2001 and supported the need for a Mission Need Statement for a Family of Non-Lethal Capabilities. The US/UK NLW Urban Operations Wargame Series explored policy questions, employment methods, future promising technologies, how to pair NLW with lethal weapons, and what future NLW core capabilities will be needed. All of these activities were designed to build upon each other. A JFCOM LOE was conducted to explore the effectiveness of non-kinetic weapons in an operational scenario (4QFY99-2QFY00). Non-lethal weapons and non-kinetic technologies have been plugged into various JTF exercises and wargames (Unified Endeavor/Unified Vision/Tempo Brave). Collaboration on developing a MOE study for NLW has been initiated with NATO allies (began 2QFY01). The JNLWP is actively engaged in CINC interaction, exercises and experiments. An MOA exists between the services, SOCOM, and U.S. Coast Guard that provides program coordination, integration, support, and direction. A Master Plan was created in 2000 to serve as a focal point defining the Vision, Goals, and Objectives for the JNLWP. Success in the accomplishment of the Master Plan will comply with Congressional and DoD directives and ultimately provide the warfighting CINCs with non-lethal capabilities to succeed in fulfilling their military objectives.

Dates:	2QFY96 to Indefinite	**Cost:**	~$150 million (FY96-FY02) @ $25m/year
Outlook:	Near/Mid/Far-term	**Focus:**	SEC/DOTMdLPCon
Sponsor:	OSD (AT&L) with Commandant of the Marine Corps serving as Executive Agent for the DoD Non-Lethal Weapons Program.		
POC/More Information:	Humberto "Rod" Rodriguez, humberto.rodriguez@2asc.com		

Joint Publication 3-06: Joint Urban Operations			
This publication will provide fundamental principles and doctrine for the conduct of joint and multinational urban operations across the range of military operations. This publication will address operational level considerations for joint force commanders and staffs and will provide doctrinal guidance focused on tasks and capabilities that are unique to, or significantly challenged by, the urban environment. The effort began 2QFY99 and the estimated completion date is 3QFY02. The review process for the second draft is currently ongoing.			
Dates:	2QFY99-3QFY02	**Cost:**	$363K (FY99-FY01)
Outlook:	Near-term	**Focus:**	USECT/DL
Sponsor:	Joint Staff/Marine Corps		
POC/More Information:	CDR Sally Degozzaldi, degozzs@js.pentagon.mil		

JWAC Urban Operations Analysis Branch			
The Joint Warfare Analysis Center (JWAC) formed an Urban Operations Analysis Branch in 2QFY00. JWAC's Urban Analysis Branch is in the early stages of constructing a Joint Warfare Analysis and Assessment Methodology (JWAAM). A summation of this proposal follows. Strategic policy makers and operational commanders have always had the requirement to understand an adversary's physical infrastructure. JWAC analysts approach these "hard" infrastructures as a series of interconnected networks and use analytical methodologies and tools to measure the vulnerability of these networks in relation to the commander's desired effects ("effects-based targeting"). There is currently no capability that considers the full range of options including the full range of kinetic and non-kinetic courses of action to accomplish effects-based operations. JWAAM proposes a "whole" solution to address this shortfall. This solution must include the analysis of cultural, social, socio-cultural and both formal and informal analysis of the "soft" infrastructure. Systematic analysis of the "soft" infrastructure determines cultural factors and dynamic social and political factors, as well as other potential leverage points. Soft and hard infrastructure analysis should then be coupled, integrated, and synergistically analyzed to further define dependencies and linkages between the two. The resultant identified linkages and dependencies may then represent exploitable vulnerabilities. Under JWAAM automated data fusion systems and integrations tools (to include those currently under development) will be exploited and matured to search conventional, unconventional, and specialized data repositories and message streams for information support of urban operations. The JWAAM template will also exploit and leverage existing databases in conducting analysis of hard and soft infrastructures.			
Dates:	2QFY00	**Cost:**	
Outlook:	Near-term	**Focus:**	U/Con
Sponsor:	JFCOM		
POC/More Information:	Marty Westphal, (540)653-2447		

Joint Urban Training Study			
This study will provide an initial inventory of urban training facilities. That information is currently being validated and verified for inclusion in the larger Joint Test and Training Range Roadmap. That roadmap information will be placed on the Internet and linked to the DoD Facility and Capability Information for Test and Training (FACITT) web network. Completion/approval of the Joint Urban Training Study information is scheduled for 1QFY02. Inclusion of the study's results on FACITT is scheduled for 4QFY01.			
Dates:	completion 1QFY02	**Cost:**	
Outlook:	Near-term	**Focus:**	/TMs
Sponsor:	Joint Staff		
POC/More Information:			

Joint Urban Working Group (JUWG)			
The Joint Urban Working Group (JUWG), sponsored by J8, is currently transitioning from its informal status to that of the formal Joint Urban Operations Working Group (JUOWG). It will serve as a working group for the Senior Studies Group (SSG) and will be the focal point for joint military requirements regarding urban operations issues until a decision is made regarding the establishment of and Executive lead for Urban operations.			
Dates:	stood up 2QFY97	**Cost:**	
Outlook:	Near/Mid/Far-term	**Focus:**	
Sponsor:	Joint Staff		
POC/More Information:	LtCol. Joe Perry, joseph.perry@js.pentagon.mil		

Joint Warfighting Science and Technology Plan (JWSTP)			
Chapter eight of the 2001 JWSTP addresses science and technology programs relevant to MOUT. The twenty programs listed address a wide range of needs including: force protection, C^3, lethal and nonlethal weapons, ISR, and mobility.			
Dates:	2QFY01	**Cost:**	
Outlook:	Near/Mid/Far-term	**Focus:**	USE/Md
Sponsor:	Joint Staff		
POC/More Information:			

Littoral Warfare Division Urban Operations Study			
This Joint Staff (J8) assessment effort has three phases. Phase One, completed in early 1999, focused on doctrine, modeling and simulation, and requirements vs. capabilities. It also included the results of a survey of CinC attitudes on MOUT. Phase Two will address ISR, C^4, concept development and a roadmap, and MOUT oversight options. Phase Three will look at MOUT training and facilities, a Joint MOUT center of excellence, future Joint and Service studies, and database development.			
Dates:	began FY98	**Cost:**	
Outlook:	Near/Mid/Far-term	**Focus:**	/DOTMdLPMsCon
Sponsor:	Joint Staff		
POC/More Information:	LtCol. Joe Perry, joseph.perry@js.pentagon.mil		

MOUT ACTD			
This joint Army-Marine Corps program has three missions: 1) to determine the military utility of advanced technologies and new operational concepts to achieve dominance in MOUT, 2) to provide interim operational capabilities to the MOUT ACTD experimental unit(s) with associated TTPs, and 3) set the stage for rapid acquisition of the successful ACTD products. As part of this effort improvements were funded in the JCATS M&S tool, a tool that gives the level of detail necessary for MOUT M&S. Up to 2QFY00 the MOUT ACTD had: completed three Army and two Marine experiments; assessed MOUT operational concepts, tactics, techniques and procedures; conducted down-selection for best-in-class prototype hardware and software based on operational performance, user acceptance, technical risks and affordability; and implemented systems integration, interoperability assessments, and diagnoses of advanced technology candidate products. The program had also conducted two joint company-level integrating experiments for interoperability assessments and refinement; developed plans for MOUT Advanced Concepts Excursion to demonstrate and evaluate more advanced science and technology-based technologies for application in an urban warfare environment; and conducted modeling and simulation (force effectiveness analyses) to quantify military utility of advanced technology candidate products. For the remainder of FY00 plans were to: conduct the MOUT Advanced Concepts Excursion; complete systems integration assessments and refinements; acquire products and prototypes for the culminating demonstration (CD) and for interim operational capability; complete New Equipment Training (NET) for CD; and conduct the MOUT Culminating Demonstration. For FY01 the plans are to: refurbish CD equipment and commence interim capability period; conduct extended user evaluations; and provide user evaluation information to appropriate combat and materiel development communities.			
Dates:	FY97-FY02	**Cost:**	$47.5 million (FY99-FY02)
Outlook:	Near-term	**Focus:**	USE/DOTMdLMsCon
Sponsor:	Army/Marine Corps		
POC/More Information:	Ms. Carol Fitzgerald, cfitzger@nul.army.mil		

Multifunctional Fabric System			
The objective of this effort is to enhance the flame and thermal protection levels of combat uniforms without compromising other protective characteristics. The technical challenge entails the integration of low-cost flame/thermal protection into other multiple threat systems to include capabilities such as electrostatic, environmental, chemical, and signature reduction. Potential technologies for use in the system are polyphenolic material coatings, microencapsulation of flame suppressants, and electrospun fibers.			
Dates:	FY97-FY01	**Cost:**	
Outlook:	Near-term	**Focus:**	S/Md
Sponsor:	Joint		
POC/More Information:	Chris Kearns (DBL), 706-545-6391		

Multinational Information Sharing & Collaboration LOEs			
This effort involves a series of three Limited Objective Experiments (LOE) with multinational partners to define and refine coalition participation in Olympic Challenge 2004. The LOEs will explore information sharing and collaboration during Rapid Decisive Operations (RDO) with coalition partners.			
Dates:	3QFY01-2QFY02	**Cost:**	
Outlook:	Near-term	**Focus:**	US/
Sponsor:	JFCOM		
POC/More Information:	LtCol. Jack Harris, harrisj@je.jfcom.mil		

Multiwavelength Multifunction Laser			
This effort will develop and demonstrate high-efficiency, compact, laser-diode-pumped laser radar (LADAR) systems in the 0.26-µm to 12-µm spectral region. The multifunctionality of single-wavelength, solid-state sources will also be investigated as a means of maximizing their utility.			
Dates:	FY01-FY02	**Cost:**	$2.6 million (FY01-FY02)
Outlook:	Mid-term	**Focus:**	U/Md
Sponsor:	Joint		
POC/More Information:	Mr. Edward Watson (AFRL)		

National Defense University Urban Operations Course			
NDU begins offering a course on MOUT in the Fall of 2001.			
Dates:	begins 1QFY02	**Cost:**	
Outlook:	Near/Mid/Far-term	**Focus:**	/L
Sponsor:	Joint Staff		
POC/More Information:			

Next-Generation Multifunction Electro-Optical Sensor System			
This program will develop and demonstrate a highly stabilized infrared search and track (IRST) sensor and signal processing technology for air and seaborne platforms. Specifically this DTO will pursue development of next-generation IRST system technology with active laser adjunct that incorporates lessons learned in previous developments such as Navy's Shipboard IRST, E2C surveillance IRST and BMDO/Navy unmanned aerial vehicle-boost phase intercept (UAV-BPI). There have been recent advances in large-area infrared focal plane arrays (IRFPAs) (DoD Electronics programs), multidimensional signal processing (services), integrated passive/active optical apertures (Navy), and electromechanical stabilization technology(services/industry) coupled with the technology base realized from prior work form the system building blocks			
Dates:	FY00-FY03	**Cost:**	$24.4 million (FY00-FY03)
Outlook:	Mid-term	**Focus:**	U/Md
Sponsor:	Army/Air Force		
POC/More Information:			

Objective Crew-Served Weapon (OCSW) ATD			
The OCSW system will provide decisively violent and suppressive target effects, including a high probability of incapacitation against protected personnel (body armor and in defilade) out to 2,000 m and a high potential to damage light and lightly armored vehicles beyond 1,000 m. The OCSW will exploit lightweight, high-strength materials; modular optoelectronic full solution fire control (leveraged from the OICW ATD program); electronic time-set fuzing; and high-explosive air-bursting munitions. The OCSW will be a lightweight, two-man portable, single replacement weapon system for the current 40 mm MK19 Grenade Machine Gun and the Caliber .50 M2 Heavy Machine Gun. Specific capabilities to include a weapon system with component weight goals as follows: weapon less than 38 lb, a ground mount less than 12 lb, ammunition less than 0.35 lb, and a fire control less than 7 lb. The system will have the capability to defeat defilade targets and 51mm rolled homogeneous armor.			
Dates:	FY97+	**Cost:**	$10.4 million (FY97-FY00)
Outlook:	Mid-term	**Focus:**	E/Md
Sponsor:	Joint		
POC/More Information:	Dr. C. W. Kitchens, Jr. (DDR&E/WT), Kitchecw@acq.osd.mil		

Protective Materials for Combatant and Combat Systems Against Conventional Weapons			
The objective is to develop and demonstrate ultra light materials and new armor principles to be incorporated into individual soldier protective gear (resulting in a 40% weight reduction); face shields and windows (resulting in a 30% weight reduction); and primary armor for combat systems (resulting in a 30% weight reduction).			
Dates:	FY97-FY03	**Cost:**	$40.5 million (FY97-FY03)
Outlook:	Mid-term	**Focus:**	S/Md
Sponsor:	Army/Navy		
POC/More Information:	Dr. Ingo May (Army Research Laboratory), (410) 278-6244		

RAND-MCWL-J8 UWG Urban Operations Conference			
This April 1999 conference was held at Bolling AFB, Washington, D.C. The aim was to provide a forum for information exchange and debate on the complete range of possible operations in urban areas likely to challenge U.S. national interests in the next generation. Approximately 200 individuals attended, including representatives from all four armed services, several joint agencies, academia, media, the commercial sector, the public service sector, and personnel from five foreign militaries. Presentations were given on a wide range of urban operations including: support missions in Haiti, combat in Grozny, WMD concerns, homeland defense, tactical issues, and operational and strategic issues. For further details on this conference see the RAND publication *The City's Many Faces*.			
Dates:	3QFY99	**Cost:**	
Outlook:	Near/Mid/Far-term	**Focus:**	
Sponsor:	Joint		
POC/More Information:	Dr. Russ Glenn (RAND), (310)393-0411, rglenn@rand.org		

Tactical Operations Support			
This effort is a part of the larger Counterterror Technical Support effort. Development activities included: specialized access tools that provides for installing anchors for supporting assault forces, a high-speed personnel delivery boat, a rifle-fired 40mm grenade with a controlled fragmentation pattern for use in close quarters battle scenarios, night vision goggles that substantially reduces the effects of halo and blooming when bright lights are encountered, a miniature laser range finder for use by snipers and other tactical forces, technologies that provide through-wall-imaging capability for use by tactical forces, non-explosive breaching capabilities, non-pyrotechnic diversionary devices, small and covert optical tags for tactical forces, and advanced tactical sensors to identify and locate anti-personnel surveillance systems.			
Dates:	FY98-FY01	**Cost:**	$6.5 million (FY98-FY01)
Outlook:	Near/Mid-term	**Focus:**	USE/Md
Sponsor:	Joint		
POC/More Information:			

Tactical UAV ACTD			
The Tactical Unmanned Aerial Vehicle, Outrider, ACTD had a goal of demonstrating a low-cost TUAV system for use by brigade-level commanders.			
Dates:	1QFY96-3QFY98	**Cost:**	
Outlook:	Near-term	**Focus:**	U/Md
Sponsor:	Marine Corps/Army/Navy		
POC/More Information:	Mr. Alex Lovett, lovettar@acq.osd.mil		

Vanguard ACTD [Proposed]			
Demonstrate an integrated, broad spectrum, tactical urban capability for the small unit (Battalion Task Force and Below) to enable US warfighter dominance in urban and other restrictive domains. Focus is on validated warfighter needs in areas of C4ISR (e.g., rapid, organic mapping creation/dissemination; intelligence collection/dissemination/exploitation; soldier position/location/status monitoring), engagement (e.g. thru-wall sensors, stand-off/remote wall breach; remote marking; sniper detection; obstacle breaching; ID/defeat booby traps, point munition), mobility (e.g., obscurants; obstacle breaching), and force protection (e.g. nonlethal crowd control; lightweight body armor, threat protection; improved obscurants, improved battlefield medical treatment). Limited objective experiments using operational dismounted forces will be conducted to evaluate technologies. The program will provide a robust dismounted assault capability and augments a medium weight force particularly tailored toward small-scale contingency operations. Focus will be on the Objective Force and provides warfighters with enabling capabilities to dominate the way we fight and win in urban and other restrictive areas. The program will leverage other Army, USMC, SOCOM, DARPA programs such as Objective Force Warrior ATD, Pathfinder ATD, and DARPA Micro Air Vehicle (MAV) etc.			
Dates:	FY03-FY05	**Cost:**	
Outlook:	Near-term	**Focus:**	USE/Md
Sponsor:	Army/MC		
POC/More Information:			

Office of the Secretary of Defense (OSD

Consequence Management ACTD			
This ACTD, for the first time, demonstrated the capability to detect and model (inside a building) a biological warfare agent simulant for consequence management. Although there are BW agent detection suites currently fielded with operational battlefield units, this was the first opportunity for the Army's Technical Escort Unit and Marine's Chemical Biological Incident Response Force to work together and acquire BW agent sensor and exercise sampling techniques suited for a rapid response, consequence management mission. This ACTD explored the capability to rapidly transition from crisis response to consequence management with early detection and identification of BW agents and proper care and treatment of victims.			
Dates:	3QFY97-3QFY98	**Cost:**	$16.2 million (FY98-FY99)
Outlook:	Near-term	**Focus:**	C/TMdMs
Sponsor:	OSD		
POC/More Information:	Dr. Judith Daly, dalyja@acq.osd.mil		

DoD Urban Operations Journal Website			
Designed to be a convenient point of access to documents, articles, reports, links to other MOUT websites, and updates on DoD MOUT activities. As of August 2000 the site was assessable for .mil addresses.			
Dates:	stood up 4QFY00	**Cost:**	$50K
Outlook:	Near/Mid/Far-term	**Focus:**	USECT/DOTMdLPMsCon
Sponsor:	OSD		
POC/More Information:	Dave Dilegge, ddilegge@alexandria.adroit.com		

DoD Urban Roadmap			
The Joint Advanced Warfighting Program, at the Institute for Defense Analyses, has the task of producing a roadmap that identifies the various MOUT efforts across DoD. A part of this effort will be analysis as to what capabilities are needed for MOUT. Current capabilities and programs will then be compared with needed MOUT capabilities and gaps highlighted. The goal will be to facilitate coordination and identify aspects of MOUT not being addressed. Delivery of the roadmap is scheduled for 3QFY01.			
Dates:	2QFY00-3QFY01	**Cost:**	
Outlook:	Near/Mid/Far-term	**Focus:**	USECT/DOTMdLPMsCon
Sponsor:	OSD		
POC/More Information:	Dr. William Hurley, whurley@ida.org		

GAO Report on MOUT			
This report by the General Accounting Office cited numerous problems with the MOUT improvement efforts ongoing within DoD. It mentioned: a lack of joint experimentation, inadequate training facilities, shortfalls in urban intelligence, and little training involving larger units. The report called for the creation of an overarching DoD strategy to improving U.S. MOUT capabilities.			
Dates:	Released February 2000	**Cost:**	
Outlook:		**Focus:**	
Sponsor:	OSD		
POC/More Information:			

JAWP Technology Workshop			
The Joint Advanced Warfighting Program held this two-day conference in November 2000. The goal was to identify emerging technologies that could provide solutions to a range MOUT challenges. Participants included active duty military, civilians from DoD and other government R&D organizations, representatives of coalition partners, IDA staff, and scientists and engineers from academia.			
Dates:	1QFY01	**Cost:**	
Outlook:	Near/Mid/Far-term	**Focus:**	USEC/Md
Sponsor:	OSD		
POC/More Information:	Dr. William Hurley, whurley@ida.org		

Office of the Secretary of Defense Urban Working Group (OSD UWG)			
Dates:	stood up 3QFY00	**Cost:**	
Outlook:	Near/Mid/Far-term	**Focus:**	
Sponsor:	OSD		
POC/More Information:			

Project Lincolnia			
This is the first attempt by the Defense of Department (DoD) to create an experimentation venue that examines military operations in urban terrain (MOUT) from a joint and interagency perspective at the strategic, operational, and tactical level. The strategic aspect was explored in the National Defense University Strategic Level Wargame (1QFY01). The results of that wargame were then fed into JTF Operational Level Wargame (1QFY01). The results from both of those wargames were then fed into the Project Metropolis Tactical Experiment (2QFY01). Project Metropolis, a previously existing effort, provided the venue to test the tactical impact of the decisions made further up the chain of command. The project was conceived as a result of the GAO report that was critical of DOD MOUT efforts as being too focused at the tactical level of military operations and paying little attention to operational or strategic level challenges. The project will attempt to provide a venue that will correct those deficiencies. It will include political, economic, cultural, and intelligence information, as well as military elements. The two overall objectives of Project Lincolnia are: 1) to test the JFCOM JTF concept, and 2) gather data on the potential for friendly casualty reduction in MOUT gained by using robotic sensors and directed energy non-lethal weapons.			
Dates:	1QFY01-2QFY01	**Cost:**	$480K
Outlook:	Near-term	**Focus:**	U/DOTMdPMsCon
Sponsor:	OSD		
POC/More Information:			

Project Lincolnia II			
This is an extension of the Project Lincolnia effort. It will include: a strategy/policy wargame (late June), an operational level wargame (late July), and a tactical urban experiment (mid-August).			
Dates:	3QFY01-4QFY01	**Cost:**	
Outlook:	Near-term	**Focus:**	U/DOTMdPMsCon
Sponsor:	OSD		
POC/More Information:	Mike Hammond, hammon@potomacinstitute.org		

Urban Operations Knowledge Center			
This effort is aimed at the problems of data base management and decision support. The goal is to provide a web-based wireless knowledge center, accessible to any user regardless of service. The center would use data mining to better manage large-scale data sources and assist decision-making. This would include the capability to retrieve and query large volumes of data rapidly as well as enabling the research of large structured and unstructured databases using complex search strategies. The development approach being used relies on existing research and COTS technologies that are inexpensive and can be rapidly put together. The center would use military, commercial, and academic lessons learned and would also incorporate existing infrastructure and applications. The tentative schedule is to produce a working prototype in six months for under $100K.			
Dates:	began 2QFY01	**Cost:**	sub-$100K
Outlook:	Near-term	**Focus:**	U/Md
Sponsor:	OSD (w/George Washington University)		
POC/More Information:	Duane Schattle, schattld@mail.policy.osd.mil		

Unified Commands

Advanced Tactical Laser ACTD			
This program aims to develop an understanding of how high power laser weapons may be employed on the battlefield , including for nonlethal purposes. The end result of the ACTD will be a laser weapon integrated into an airborne platform such as the V-22, C-130, H-53, or H-47. The design will be for a roll-on, roll-off package with minimal logistical requirements. The expected laser output will be 50 kilowatts with an effective lethal range in excess of ten kilometers.			
Dates:	FY01-FY06	**Cost:**	$23 million (FY01-FY06) (from JNLW budget)
Outlook:	Mid-term	**Focus:**	E/DMdCon
Sponsor:	SOCOM		
POC/More Information:	LtCol. Pat Gardner, USAF, SOCOM		

Battle Damage Assessment in Joint Targeting Toolbox			
The lack of accurate and timely battle damage assessment during combat operations is identified as a critical shortfall for the JFC. Current BDA only reports the observed physical damage. The objective of this program is to create automated BDA support for qualitative and quantitative assessments to determine functional damage to targets; a more accurate measure of effectiveness. FY01 plans were to integrate additional components and to include comparison of combat objectives with actual results and BDA report generation. A military utility assessment will be conducted in a CENTCOM joint exercise.			
Dates:	1QFY99-FY02	**Cost:**	$1.24 million (FY99-FY01)
Outlook:	Near-term	**Focus:**	U/Md
Sponsor:	CENTCOM		
POC/More Information:	Mr. Mike Maggiano, afdimma@dia.osis.gov		

Consequence Management Exercise (Tempo Brave)			
The emphasis of this exercise was on dealing with the impacts of a WMD use on civilians and civilian infrastructure.			
Dates:	1QFY01	**Cost:**	
Outlook:	Near-term	**Focus:**	C/T
Sponsor:	PACOM		
POC/More Information:			

Pathfinder ACTD [Proposed]			
A tactical level look at employing robotics with special operations forces in MOUT.			
Dates:	FY02-FY05	**Cost:**	
Outlook:	Near-Term	**Focus:**	
Sponsor:	SOCOM		
POC/More Information:			

Preemptive IRCM (PIRCM) Prototype System [Proposed]			
Electro-optic and infrared (EO/IR) sensors and missile seekers continue to proliferate on enemy air defense systems worldwide, allowing them to passively acquire, track and launch on aircraft without warning, day or night. From Chechnya to Kosovo, shoulder-fired missiles have become the weapon of choice in urban areas and for insurgent forces. These man-portable systems take maximum advantage of the cover provided by the urban landscape, making both early detection and engagement very difficult. This threat has denied low altitude airspace, which stresses sensors, target identification, and weapon delivery, and places at risk direct aerial support to ground operations. Emerging directed IR countermeasure systems will provide an improved defensive capability over flares, but with shortfalls in urban scenarios such as inadequate warning time or high false alarm rates. A preemptive IRCM (PIRCM) system will detect, identify, locate and jam these seekers and tracking sensors prior to launch. Locating the threat will allow us to return fire, deterring future launches and forcing the adversary to alter their tactics. This effort will build a PIRCM prototype system for tower testing. The prototype system will enable alternate configurations and algorithms to be tested quickly and cheaply. In addition, it will be used to perform risk reduction experiments including threat sensor characterization to determine their susceptibility to detection and countermeasures; algorithm development for false alarm reduction and threat identification; and validation of performance models. This capability will be demonstrated in the Day/Night EO/IR Tracker CM ATD and transition to AFSOC fixed-wing aircraft through P³I upgrades to the DIRCM system. It will not interfere with basic functions of missile warning and in-flight IR missile countermeasures. *(continued on the next page)*			
Dates:	FY03 – FY05	**Cost:**	$1.2M - $1.5M
Outlook:	Mid-term	**Focus:**	S/Md
Sponsor:	SOCOM		
POC/More Information:	Capt Michael Hawks, AFRL/SNJW, 937-255-4174x4009, Michael.Hawks@wpafb.af.mil		

SOCOM Urban Working Group (SOCOM UWG)			
Special Operations Command established the SOCOM UWG to identify and address SOCOM specific urban requirements and address existing shortfalls. Currently, it serves as the SOCOM focal point for advocacy, coordination, deconfliction, collaboration and connectivity.			
Dates:	stood up 1QFY98	**Cost:**	
Outlook:	Near/Mid/Far-term	**Focus:**	
Sponsor:	SOCOM		
POC/More Information:	Maj Wes Loffert		

Special Operations Forces Urban Wargame/Seminar			
A SOCOM activity held in February 1999 to explore the role of SOF in MOUT.			
Dates:	2QFY99	**Cost:**	
Outlook:	Near-term	**Focus:**	
Sponsor:	SOCOM		
POC/More Information:			

Urban Target Detection and Identification Using Multi-Spectral and Hyperspectral Imaging (Urban MSI/HIS) [Proposed]			
Using concepts developed in hyperspectral imaging this effort would use signature exploitation in the visible, short/mid/long infrared wavelengths to detect, locate, and classify targets. Existing data from the airborne Urban Radiance II HSI data collection will be analyzed to validate the capability of HSI to discriminate military targets in the urban environment. The Urban Radiance II data collection occurred during Jun 00, and includes military personnel, numerous vehicles in/around villages, materials and pre-surveyed military vehicles in industrial/city locations with the associated ground truth data. Findings from this analysis will be verified and demonstrated through sensor tower testing. The objective is to demonstrate detection, location, and IFFN functions in an urban environment with a limited number of spectral bands, leading to an affordable tactical sensor system.			
Dates:	Proposed FY03 Program	**Cost:**	$500K
Outlook:	Mid-term	**Focus:**	U/Md
Sponsor:	SOCOM		
POC/More Information:	Walter Harrington, AFRL/SNZC, 937-255-5351x4300, Walter.Harrington@wpafb.af.mil		

Allied

Multinational Experimental Symposium			
The Norwegian MoD will host this JFCOM-sponsored event in September 2001. This symposium is JFCOM's effort to "reach out" to allies and potential multinational partner nations. The theme is experimentation; the number one mission of JFCOM, and the intent is to expand the dialog to a host of nations and set the stage for inclusion of greater numbers of them to participate in future JFCOM-sponsored joint/combined experimentation. This event is aimed at the near-term. Follow-on activities will be aimed at both the near and mid-term.			
Dates:	1QFY02	**Cost:**	
Outlook:	Near-term	**Focus:**	
Sponsor:	JFCOM		
POC/More Information:			

NATO SAS-035 Nonlethal Weapons Measures of Effectiveness			
This effort is aimed at developing improved measures of effectiveness for nonlethal weapons.			
Dates:	4QFY00-1QFY03	**Cost:**	$350K (from JNLW budget)
Outlook:	Near/Mid/Far-term	**Focus:**	E/DOMdMsCon
Sponsor:	OSD		
POC/More Information:			

NATO Urban Operations in the Year 2020 Study			
A NATO effort, with OSD involvement, examining the future of MOUT. A draft report is due early in 2002 and a multinational exercise is planned for mid-2002.			
Dates:	began 3QFY00	**Cost:**	
Outlook:	Far-term	**Focus:**	
Sponsor:	OSD		
POC/More Information:			

United Kingdom Urban Conference			
This event is sponsored by the UK Joint Command and Staff College. Invitees will include NATO members, Australia, and Brazil. Scheduled for June 2001, the intent of the conference is to address urban operational issues that need to be co-evolved multinationally at the strategic, operational, and tactical levels of operations. Issues at the strategic and operational levels will include military interoperability, multinational governmental diplomatic-military relationships, and multinational civil-military affairs (operations with and among IO/NGOs). The recommendations resulting will be reported to the MoD of each nation to heighten interest in increasing capabilities to operate in urban environments.			
Dates:	3QFY01	**Cost:**	
Outlook:		**Focus:**	
Sponsor:			
POC/More Information:			

Appendix B.
Current Activities and Future Directions for Ground Vehicles, Medical Support, and Mobile Robots

Contents

I. Ground Vehicles In Urban Operations 3
- A. Armor Protection 3
- B. Communications 4
- C. Vehicle Design 4
- D. Training 4
- E. Mobility 5
- F. Firepower 5
- G. Logistics 5
- H. Current Activities 6
- I. Some Possible Directions 8
- J. Conclusions 9

II. Medical Support in Urban Operations 9
- A. Understand 9
- B. Shape 10
- C. Engage 10
- D. Consolidate, Transition 11
- E. Conclusions 11

III. Mobile Robots for Urban Operations 12
- A. Mobility 12
- B. Delivery Systems 13
- C. Form 13
- D. C3I 13
- E. Video Information 14
- F. Video Guidance and Control 14
- G. Video Networks 14
- H. NETEX (NETworks in the Extreme) 15
- I. Conclusions 15

This appendix discusses activities and future directions in three special areas affecting urban capabilities: Ground Vehicles, Medical Support, and Mobile Robots.

I. Ground Vehicles In Urban Operations

The urban environment places unique demands on every component of a military force, ground vehicles being no exception. The utility of current US ground vehicles suffers from six general limitations in military operations on urbanized terrain (MOUT): armor protection, communications, training, mobility, firepower, and logistics. Each limitation is discussed in the following sections.

A. Armor Protection

Providing armor protection for vehicles in the MOUT environment is difficult because of the drastically decreased engagement ranges and the wealth of cover for dismounted infantry. That in turn levels the technology playing field by allowing low-tech infantry forces to more effectively engage vehicles of all types. At 1,000 meters, light-weight and inexpensive small arms and man-portable anti-tank weapons pose a minimal threat to vehicles. However, at 50 meters they pose a threat akin to precision-guided weapons.

For the M1 Abrams tank, hits on the frontal or side arcs (with rocket-propelled grenade (RPG)-like warheads, for example) would cause minimal damage with the current armor packages. However, if the Abrams is hit from above on the turret or the rear engine deck, or the rear of the vehicle, the likelihood of damage is substantially higher. Tanks have historically possessed their thinnest armor in these areas because hits on those areas were the least likely. MOUT changes that. With the wealth of cover and the vertical nature of urban terrain, these thin portions of a tank's armor can be hit. This was recently demonstrated in Grozny, where Chechen infantry would perch on third-floor balconies, waiting for Russian armor to pass below.

Lighter armored vehicles (e.g., Bradley, Amphibious Assault Vehicle (AAV), etc.) are even more vulnerable to RPG-like weapons, with even the frontal arc lacking sufficient protection. While many of these vehicles can be fitted with reactive armor packages, that protection has its limitations. Reactive armor adds substantially to a vehicle's weight and cost.[1] Additionally, individual reactive armor tiles are single-use items. Once a tile

1 According to a 1999 RAND report, equipping a Bradley Fighting Vehicle with reactive armor would cost around $260,000 and weigh between 6,900 and 7,600 pounds. That equates to more weight than a Humvee, and more cost than is needed to purchase four new Humvees. See John Pinder, *Reactive Armor Tiles for Army and Marine Corps Armored Vehicles*, RAND Corporation, Santa Monica, CA, 1999), p. xiv.

has been activated it offers no further protection from subsequent hits.[2] In several conflicts over the last decade, there have been examples of infantry forces exploiting this weakness by directing multiple shots to one location on reactive-armor equipped vehicles (not a difficult task given the engagement ranges).[3] For unarmored vehicles, even small arms pose a threat. Most of the vehicles used for logistics are unarmored, thus making resupply operations in close proximity to Red forces difficult. USUS forces in Mogadishu suffered heavy casualties when they tried to move about the city in trucks and HUMVEEs.

B. Communications

A second limitation relates to communications. Buildings frequently disrupt the currently fielded radio and Global Positioning Systems (GPSs) on USUS ground vehicles. That disruption is especially problematic given that the limited lines of sight in the urban environment will place an even greater burden on radio and GPS capabilities for command and control. The ability to operate forces in a dispersed manner will be greatly hindered if radio and GPS systems cannot be made more functional in the city.

C. Vehicle Design

The third limitation relates to the vehicle design and the role of vehicles in combined arms. One example is the Abrams tank, which is less adaptable to working closely with infantry than its predecessor (M60). It lacks an external phone, and its hot exhaust port to the rear of the vehicle makes it difficult for infantry to use it for cover. Both the Bradley and LAV have relatively small capacities for dismounted troops (six each). This could prove a problem for infantry-intensive urban operations.

D. Training

Aside from vehicle design issues, there is the issue of training in combined arms. The constricted nature of urban terrain will tend to break up units into their smallest components. Those components will need to be capable of functioning as combined arms teams even at that small unit level (e.g., one squad with one tank). However, current training places little emphasis on small unit combined arms.[4]

---

2 Russian armored vehicles in Grozny in 1995 received many of these subsequent hits. On average, the Russian vehicles destroyed had received half a dozen lethal RPG hits. See Lester Grau, "Russian-Manufactured Armored Vehicle Vulnerability in Urban Combat: The Chechnya Experience," *Red Thrust Star* (January 1997), pp. 16–19.

3 Lester Grau, "The RPG-7 On the Battlefields of Today and Tomorrow," *Infantry* (May-August 1998), pp. 6-8.

4 During the PROJECT METROPOLIS experiment, more than 90% of the Marines participating stated that they had *never* conducted operations with a tank. Marine Corps Warfighting Laboratory, *Project Me-*

E. Mobility

Regarding mobility, the width of the Abrams (12 feet) may exceed the width of some urban roads and alleys. The weight of the Abrams (70 tons), Bradley (25 tons), and AAV (30 tons) may exceed the capacity of some bridges, especially in the Third World. Just driving down rubble-strewn streets may prove difficult for some wheeled vehicles. Wheeled vehicles require wider turning radii than tracked vehicles, which may be a problem on narrow streets.

F. Firepower

Another concern relates to firepower. Engaging close targets in the urban environment will sometimes require extreme elevation or depression of direct fire weapons. The Abrams and other USUS vehicles may have difficulty in this area. The fire support contribution of the Abrams is also limited against building and infantry targets by its current ammunition selection. The current APFSDS[5] round produces too little fragmentation and would over-penetrate most targets. The M830A1 HEAT (high explosive anti-tank) round is optimized for long-range armor penetration rather than blast and fragmentation effects. A canister round would be very useful against infantry targets. The minimum engagement range of the TOW missile may preclude some engagements. Blocked flight trajectories may be a problem for both direct-fire and indirect-fire systems. Because some targets may be sheltered by intervening buildings, munitions with agile trajectories and non-line-of-sight attack capabilities would be desirable.

G. Logistics

The last limitation is logistics. Urban operations are likely to require dispersed operations. Having the luxury of a secure rear area, through which supplies can be safely delivered, cannot be counted on. The current unarmored resupply vehicles would have difficulty in delivering across unsecured terrain. Dispersed operations will place a premium on vehicles being able to operate for extended periods without resupply. However, the heavy logistical tail required by many USUS vehicles makes those operations difficult. For example, the Abrams carries only 40 main gun rounds and the vehicle's fuel consumption is high.

---

tropolis Military Operations in Urban Terrain Battalion Level Experiments: Experiment After Action Report, US Marine Corps, Quantico, VA, February 2001, p. 6.

5 Armor-Piercing Fin-Stabilized Discarding Sabot.

H. Current Activities

At first glance, all of these limitations might appear to make improving USUS vehicles too problematic. However, not doing so would deny USUS forces two basic tools for the future urban fight: *combined arms* and *mobility*. Combined arms in MOUT, with some adaptation, offers the same synergistic benefits it offers in open terrain. The After Action Report to the Marine Corps' PROJECT METROPOLIS called combined arms (along with training) one of the two keys to winning the urban fight.[6] Vehicles provide both direct (carrying infantry) and indirect (carrying supplies for infantry) mobility for dismounted personnel. Without that mobility, conducting rapid maneuver in the urban environment would be more difficult. The key is to look for solutions to these concerns across the full span of DOTMLPF[7] so ground vehicles can play a key role in future urban operations. Unfortunately, there are few ongoing efforts aimed at correcting these limitations.

Armor protection. In the area of improving armor protection, there have been some efforts to develop reactive armor for some lighter armored vehicles (Bradley, LAV III). However, as already noted, that option adds substantially to a vehicle's cost and weight while providing only limited protection against multiple hits. Some of the efforts aimed at improving infantry body armor may have application to protecting unarmored resupply vehicles. One such effort is at DARPA, the Protective Materials for Combatant and Combat Systems Against Conventional Weapons, which is looking at lighter weight armor for vehicles.

Communications. Some potential solutions to the vehicle communications problem in MOUT may come out of the various efforts to improve the communications of dismounted personnel (e.g., the MOUT Advanced Concept Technology Demonstration, Small-Unit Operations (SUO), Land Warrior are all working to resolve this problem). Another possible solution could relate to unmanned aerial vehicle (UAV) programs. Used as communication relay nodes, UAVs could make today's line-of-sight radios more effective.

Training. The two most notable efforts with regard to improving combined arms training are the Marine Corps' PROJECT METROPOLIS and the work of the Army's Combined Arms MOUT Task Force (CAMTF). PROJECT METROPOLIS has concluded that:

- combined arms is essential to the urban fight,
- current combined arms training is inadequate, and

---

6 Marine Corps Warfighting Laboratory, *Project Metropolis Military Operations in Urban Terrain Battalion Level Experiments: Experiment After Action Report*, US Marine Corps, Quantico, VaA, US Marine Corps, February 2001, p. 7.

7 Doctrine, Organization, Training, Materiel, Leadership, People, Facilities.

- an urban-specific combined arms training regime is needed.

PROJECT METROPOLIS has produced just such a package, BUST, the Basic Urban Skills Training, which is currently under review by the Marine Corps Training Command.

The Army's CAMTF has recently completed an overall MOUT training strategy for the Army that was approved by the Training and Doctrine (TRADOC) Commander in March 2001. This training strategy, which is awaiting final Army Chief of Staff approval, recommends new training facilities, including one for combined arms. However, there is still a current lack of joint MOUT training. One factor influencing that lack of activity may be the paucity of MOUT training facilities larger than village size. To realistically include indirect fire support, aviation support, and larger units in training requires either larger facilities or facilities that are electronically linked to create virtual large facilities.

Mobility. On the subject of mobility, the Army's equipment decisions for Interim Brigade Combat Teams (IBCT) look to address some of the problems of the current vehicles. The LAV III (troop transport variant) selected for the IBCT has several advantages over the Bradley:

- carries more troops than a Bradley (nine soldiers vs. six soldiers),
- weighs less (19 tons vs. 25 tons),
- is narrower (107 inches vs. 126 inches), and
- uses less fuel (5.7 miles per galleon vs. 1.7 miles per galleon).

The Mobile Gun System variant of the LAV III, with 105mm gun and at 21 tons, could cross many bridges that the Abrams could not.

Firepower. On the question of firepower, there has been an Army effort to develop a 120mm canister round for the Abrams. The prototype XM1028 round contains 900 to 1,000 tungsten balls that would be very effective when pitted against infantry targets at 200 to 500 meters. However, the program has no funds for procurement or further development at this point.[8]

Logistics. With regard to logistics, vehicles such as the LAV III would ease the burden of supplying units operating in a dispersed fashion. The ongoing Precision Offset High-Glide Aerial Delivery of Munitions and Equipment program is developing GPS-guided high-glide wing technology. In 1995 the Army made a limited purchase of the Guided Parafoil Airborne Delivery System. If systems like these were available in quantity, they

---

8 More information available at http://knox-www.army.mil/center/tsmabrams/information_papers.htm.

could obviate the need to resupply isolated forces via ground vehicles or helicopters. In PROJECT METROPOLIS, the small six-wheeled Gator vehicle was found to be a very useful resupply vehicle, in addition to being the most survivable vehicle in the experiment. The Small Unit Logistics ACTD is exploring how to build a better Combat Service Support (CSS) system for units operating on a dispersed battlefield.

I. Some Possible Directions

Armor protection. One solution to the armor protection problem that has received little attention is lightweight standoff screens. Extended screens of metal mesh or bar arrays could detonate incoming RPG rounds several feet from the vehicles. This solution would be much lighter than current reactive armor sets while costing much less. Much like reactive armor, these screens could be stored until urban operations were imminent. Once damaged, these screens could be quickly replaced from spares carried on the vehicles themselves. *Unfortunately there appears to be no ongoing efforts at developing this low-tech solution.*[9] Increased attention should also be focused on providing small arms protection to logistics vehicles, perhaps also in a modular kit form that could be applied as needed to vehicles involved in MOUT.

Communications. There needs to be more attention to the urban communications needs of vehicles. UAV programs need to view communications relay as a core task. The efforts of those programs developing non-line-of-sight radios for dismounted personnel need to be leveraged for vehicles.

Training. Small unit combined arms training in an urban environment needs to become part of the regular training syllabus of the Army and Marine Corps. These two Services should aggressively follow through on their initial steps toward an urban combined arms training capability. Future MOUT training should incorporate all elements of the force likely to be used: rotary-wing transport and fire support; fixed-wing aircraft; and ground and naval fire support. Additionally, a greater emphasis needs to be placed on joint MOUT training. While tracked vehicles are capable of dealing with rubble, the wheeled vehicles of the force may not be. Analysis should be done into the sufficiency of current engineering capabilities to clear rubble-blocked streets.

Firepower. To improve urban firepower the following should be explored: an expanded range of ammunition for the Abram's 120mm gun (canister, HE (high explosive)), inex-

---

9 This article calls lightweight standoff screens the best short-term solution to the RPG threat. See Lester W. Grau, "The RPG-7 On the Battlefields of Today and Tomorrow," *Infantry* (May-August 1998), pp. 6–8. Russian tanks were rigged with standoff screens for RPG protection in Grozny in 1995. See Capt. Chad A. Rupe, "The Battle for Grozny," *Armor* (May-June 1999), p. 20+. Russian vehicles in the second Chechen conflict (1999–2000) began showing up with standoff bar armor for RPG defense.

pensive TOW replacement for use by the Bradley/LAV/LAV III with shorter minimum engagement ranges and improved warheads (possibly thermobaric), and missiles with agile trajectories that allow engagement of targets outside of a vehicle's line-of-sight (e.g., EFOGM, the Enhanced Fiber Optic Guided Missile).

Logistics. The efforts to improve urban logistics capabilities would benefit from an increased ability to airdrop supplies to isolated forces without placing a helicopter, fixed-wing aircraft, or ground vehicle at risk. This may require further development of guided airdrop technologies and/or increased procurement of the equipment required.

J. Conclusions

In general, current US ground vehicles are not well suited for MOUT. While there are efforts to improve them, more efforts are needed.

II. Medical Support in Urban Operations

In the main body of this report, the Medical Support Function to Blue Forces was inserted in the Shape category of USECT. But in reality this function crosses all USECT categories, and has, in fact, its own set of USECT sub-categories.

Although improving the Medical Support Function has been addressed in many exercises and experiments such as URBAN WARRIOR, PROJECT METROPOLIS, etc., the emphasis has been largely at the tactical level. Indeed, important strides have been made in training medical personnel to provide quality care in the urban environment (e.g., the "Tactical Medicine in Naval Special Warfare" has been used widely in the special operations community). Recent efforts, such as the US Army Medical Department's conference on Medical Support of Military Operations on Urban Terrain in October 2000 have begun to address the issue at more doctrinal and operational levels. Futuristic efforts, such as implantable microchip technology for remotely monitoring personnel, unattended ground and air vehicles that can serve as ambulances, and telemedicine initiatives, still focus predominantly on the tactical picture with some operational overlap.

As mentioned, medical support to the joint or coalition commander can be divided into components or phases identical with those of urban operations themselves: Understand, Shape, Engage, Consolidate, and Transition. These phases are dynamic, incessant, and interdependent; and they are applicable across the entire range of military operations. *In particular, the Understand phase of Medical Support Function is continuous and, conceivably, of paramount importance.*

A. Understand

In the Understand phase, the logistical requirements of combat health support as well as non-combatants' health support in the urban battlespace provide new challenges for

Blue Forces while traditional medical threats such as diseases and non-battle injuries will still far surpass battle casualties in reducing force effectiveness. Information concerning medical issues unique to a particular geographic area for the Understand phase is principally provided by the Armed Forces Medical Intelligence Center (AFMIC). AFMIC Using the real-time, three-dimensional situation awareness information made available through the Battlefield Augmented Reality System (BARS), AFMIC supplies intelligence on host-nation medical support capabilities, endemic diseases, and hazardous material sources. This will allow the Joint Force Commander (JFC) to protect Blue Forces and to craft tactics, techniques, and procedures (TTP) to achieve operational objectives. These data will identify conditions that might affect the Blue and Red Forces as well as the local populace.

B. Shape

The Shape phase of Medical Support involves the JFC's employing preventive medicine measures for force protection and coordinating with host nations for using previously identified medical facilities and potential locations for Blue medical units. Force protection is achieved through such means as discipline, vaccines appropriate to endemic diseases, prophylactic antibiotics, vector control, sanitation procedures, water testing, and food screening. *Implementing preventive medicine measures cannot be over-emphasized to the Blue Force commander.* Furthermore, previously acquired intelligence concerning the medical capabilities of the enemy, non-combatant organizations, and non-governmental organizations (NGOs) can assist the commander in devising ways to isolate or otherwise deny Red Forces access to medical facilities and supplies, or to control the non-combatant population while assuring Blue Forces' health through such access and control.

C. Engage

Engagement for the medical support function involves casualty care and very limited medical screening of non-combatants. Casualty care may take many forms: self-aid, buddy care, care by medics, evacuation, and/or definitive treatment at relatively sophisticated medical facilities such as field hospitals, hospital ships, or fixed host-nation amenities. Although not purely medical roles *per se*, the search, rescue, extraction, and medical evacuation functions are vastly complicated during operations in the urban environment. Because Blue medical support functions will face threats from Red Forces in the urban area, substantive medical facilities may be far removed from the area of operations. In the city, providing appropriate care at the scene or finding and moving casualties to an area where they can receive that care will be necessary. These medical evacuation platforms and facilities will require enhanced security and protection. In general, much work needs to be done to evaluate better ways of providing these functions.

Medically screening non-combatants by Blue Force medical personnel can provide valuable intelligence to assist the JFC. A routine medical examination of non-combatants

and prisoners can disclose evidence of nutritional deficiencies or violence in the urban area. This can help identify diseases, subsistence problems, quality of medical personnel, medical supply shortages, and the presence of combatants amongst non-combatants. With such confirmed information, the JFC can have psychological operations personnel target specific populations, enemy organizations, and even specific enemy personality traits with promises of definitive medical treatment or other assistance, possibly resulting in significant defections. He could also ensure that non-combatant populations are combatant free.

D. Consolidate, Transition

Although more of a Civil Affairs than medical function, both Consolidate and Transition phases of the Medical Support Function involve restoring medical services to captured areas. These functions necessitate working closely with allies, international agencies, NGOs, and civilian authorities. After the Engage phase, Blue Force medical personnel can continue to screen, but they will also advise, assist, and even provide limited treatment to the civilian population on a humanitarian basis. Others, however, will be tasked to re-establish the health care system.

E. Conclusions

In summary, the urban environment presents many challenges to providing appropriate medical care to Blue Forces. Non-battlefield issues such as damaged infrastructure and hazardous materials, a civilian population that is a vector for communicable disease and terrorism, and the markedly increased psychological stress levels of fighting in the city will force medical personnel to find innovative ways of working in these operations. To date, most exercises and experiments have focused on the TTP of the Medical Support Function. The Department of Defense must focus on the following areas:

- **Doctrine.** Service, joint, interagency, and coalition organizations must develop doctrine for medical support in the urban environment.

- **Combat stress control.** History has demonstrated that fighting in the city results in a significant number of psychological casualties. Preventing and treating these casualties are of utmost importance.

- **Evacuation policies and procedures.** The urban environment presents the challenges of moving casualties from buildings (the vertical dimension) as well as moving them over rubble-strewn city streets (the horizontal dimension). New methods of search, rescue, extraction, and medical evacuation must be developed and evaluated.

- **Casualty care in austere and remote circumstances.** Treating casualties in the urban environment is immensely complex. While training medical personnel to

provide this care is vital, training all personnel in buddy care is ideal. The special operations communities embrace this concept, but it needs to be expanded to all forces.

- **Casualty prevention.** Force health protection is one of the JFC's highest priorities. Using solid intelligence, established preventive medicine practices, and high-quality medical command, control, and communications procedures will help ensure the well being of Blue Forces.

- **Interagency, non-governmental organizations, and coalition cooperation.** Dealing with diverse national and international organizations and interests is a challenge to the force commander and his medical representatives. Open communications, continuing dialog, and face-to-face negotiations will help ensure smooth coordination of these varied efforts.

III. Mobile Robots for Urban Operations

As security forces play a continuous role in world affairs, and the need for MOUT increases, so will the desire to apply technology solutions to that difficult battlespace. The role of the intrusion sensor and the surveillance camera is well known in home, commercial, and urban security markets. In addition, the USUS military research and development community has made considerable investments in technologies that can be applied to these systems, such as work in image understanding (including human detection systems), computer vision, visualization, and sensor technology. A key mechanism for USUS military dominance in MOUT is to leverage these sophisticated tools regarding intrusion detection, surveillance, and monitoring into systems available to deploying units.

The need to operate these systems in denied or semi-denied areas creates tremendous challenges for the installation and use of such systems. The large scale of a MOUT operation creates additional challenges. Finally, MOUT operations are limited in time. Any viable system would have to set up almost instantly. Mobile robots may offer the solution to these problems. A key mission of urban robots will be to support the rapid deployment and continuous operations of intrusion detection, surveillance, and monitoring systems. Both the physical mobility and command, control, communications and intelligence (C3I) management functions are discussed in the following sections.

A. Mobility

A probability of compromise should be a factor in any overall system design. Ongoing mobile robot efforts have tended to concentrate on the most straightforward mobility aspects, for example, the ability to carry payloads for a distance over a variety of terrain types. The result is a collection of systems optimized, with large treaded tires or tracks, for open terrain with some climbing, and able to carry a battery pack to support the

traverse. DARPA's Distributed Robotics effort and a handful of others have been looking at alternative mobility types such as snakes, multi-peds, and vacuum systems. Small-scale approaches like piezoelectric actuators and MEMS (micro-electro-mechanical systems) thrusters provide other alternatives. Some systems require hours to move inches while others can move quickly, but are cumbersome because of the large battery pack required. *In any case, the majority of the volume and power requirements of a robot tend to be consumed by its mobility requirements.*

B. Delivery Systems

Focusing the mobility requirements on urban applications will bring about a different solution set. An example of this is a program sponsored by DARPA's Advanced Technology Office (ATO), which resulted in a 40mm camera system that, when shot from a grenade launcher, would impact a wall and actuate an internal nail gun that would hold it in place after the impulse. One could start to imagine robots whose mobility aspect might be a grappling hook or trammel line, rather than wheels or treads, to quickly scale the exteriors of buildings. The Scout robot developed under DARPA's Distributed Robotics program comes very close to this capability: it is 40mm in diameter and includes all the functional components such as wireless PTZ (pan-tilt-zoom) camera, command and control, wheels, and a winch to wind up a spring. A final aspect to consider is that the distances required for MOUT operations may be covered by a long-range delivery system coupled with a short-range emplacement system. Currently available delivery systems such as the M203 grenade launcher or existing chaff and flare dispensers should be pursued.

C. Form

Urban robots must be designed such that they are not easily compromised. Some possibilities here would be to design robots that are small or low profile, can be deployed in great numbers, can attach themselves in places that are difficult to access, are highly energetic and can move at great speeds, or have some built-in defense mechanism. Robots in urban environments will operate in close proximity to the indigenous population, and compromise will most likely occur. Therefore, a probability of compromise should be a factor in any overall system design. While they may never become invisible, a device with muted coloring, and that is less than 3 inches on a side, is difficult to resolve at urban distances (20ft. to 200ft.). This size of a device can hide in such areas as trees, gutters, awnings, rooftops, and wheel wells.

D. C3I

Designing the C3I interface for urban robots is an extreme challenge that, much like the case of mobility and form, has not been addressed by any of the ongoing robotics efforts. An intrusion, surveillance, and monitoring system will require a minimal amount of area coverage and will be located in the relative proximity to its subject. For human

activity (face recognition or movement monitoring), an adequate number of pixels across the facial features or resolution adequate to distinguish hand features apart from other objects hints at the amount of raw data that will be collected at each sensor head.

E. Video Information

It is extremely unlikely that future urban operations will be conducted without the benefit of visual sensor information about the target area. Robotic sensors will collect sensor information about the target as well as wide-area background data to provide context. The combination of sensor information and geospatial context will form the basis for inclusion of all reference data and all data to be referenced. The level of detail provided by currently available mapping products will not meet the needs of sensors and systems operating autonomously or even semi-autonomously (not to mention the situation awareness needs of the warfighter). Here the robotic sensors could perform an extremely important function.

F. Video Guidance and Control

Future guidance and control systems operating in an environment filled with structures and obstacles will need a closed-loop system. A geo-registered sensor database updated in real time will be the reference for this type of closed-loop system. DARPA and the Services have several programs that address the need for this type of geospatial referencing of video sensor data. In addition, mature image understanding technologies exist that can begin to form track files for moving objects found within the image, and the separation of entities (e.g., people, faces, vehicles.). Other data, such as acoustic, voice, electromagnetic, or biological or chemical, can be subsequently correlated with entity track files. *In short, a tremendous amount of information can be obtained simply by collecting a fused picture from these types of local surveillance sensors.* The challenge is to set up adequate C3I from ad-hoc groups of robots so that this collaboration might occur.

G. Video Networks

Networking and C3I not only will enable the application of these sophisticated technologies, but they are also essential for operating groups of sensors in close proximity. Radio frequency (RF) bandwidth is a limited commodity and a risky resource in denied territories. Current wireless video systems operate at nominally NTSC format; however, most off-the-shelf transmitters used by robot manufacturers transmit in a limited set of frequency bands. The result is that if more than two are in close proximity (say, one or two city blocks), they are jammed.

Recent developments in wireless web-cameras have offered a capability to transmit to limited distances, low-resolution digital video over wireless local area networks (LANs) (802.11B). This is a great step forward, but much work remains to be done to operate more than 10 sensors at once, to allow them greater range, and to make them LPI/LPD

and energy efficient. Current progress in DoD ad-hoc network programs has brought some limited applications of multi-hop systems. To name a few, DARPA's Small Unit Operations program and the SensIT program demonstrated such limited ad-hoc networking capabilities. Some work was also demonstrated under programs managed by the Special Operations Command and the Office of Naval Research. The systems demonstrated remain small in the number of nodes supported, and large in computational requirements.

H. NETEX (NETworks in the Extreme)

An ad-hoc network suitable for MOUT robots presents extreme challenges. The harsh RF environment, with interference and multipath, and the extreme constraints in robot size and potential numbers points to hierarchical or cellular techniques to include the presence of intermittent higher-powered nodes and base stations. UAV nodes and relays are also good candidates for aiding low-power microsystems. Ad-hoc networks focused on supporting MOUT systems are proposed as part of a DARPA FY02 new start proposal, NETEX (for NETworks in the EXtreme).

I. Conclusions

Despite large expenditures by DoD for mobile robots, their utility has yet to be demonstrated. It is still too difficult to communicate with, and control, mobile robots. Autonomous robots will fail in urban environments until mapping and control schemes can mature to the level of complexity required.

- As a first step, robots must be integrated into an adequate C3I capability.
- Second, robots function well when they are properly designed for a specific task. Mobile robots do not have adequate mission definition. For MOUT operations, installation and management of intrusion detection, surveillance, and monitoring systems is a suitable mission for mobile robots, but significant re-engineering is required to adapt them to this mission.

Appendix C.
Bibliography

This appendix contains the bibliography, first grouped by subject and then by author. The subject areas are as follows:

Bibliography, Arranged by Subject 3
- Aviation 3
- Combined Arms; Armor 3
- C4ISR; Leadership 4
- Doctrine 5
- Experimentation 5
- General 5
- History 8
- Logistics 10
- Training 10

Bibliography, Arranged by Author 11

Bibliography, Arranged by Subject

Aviation

Hewson, Maj. Harry J. "Light/Attack Helicopter Operations in the Three Block War." *Marine Corps Gazette* (April 1999): pp. 25–27.

Kitfield, James. "War in the Urban Jungles." *Air Force Magazine* (December 1998).

Schwartz, Lt. Gen. Norton A. (USAF) and Col. Robert B. Stephan (USAF). "Don't Go Downtown without Us." *Aerospace Power Journal* (Spring 2000): pp. 3–11.

Rose, Col. Daniel R., Maj. Eric F. Buer, and Capt. Patrick S. McDoniel. "Close Air Support Ranges for the Urban Warrior." *Marine Corps Gazette* (May 2000): pp. 69–72.

Thomas, Timothy L. "Air Operations in Low Intensity Conflict: the Case of Chechnya." *Airpower Journal* (Winter 1997): pp. 51–59.

US Department of Defense. *Report to Congress: Kosovo/Operation Allied Force After-Action Report*. Washington: US Government Printing Office, 2000.

US Marine Corps. Marine Aviation Weapons and Tactics Squadron One. *Aviation Combat Element: Military Operations on Urban Terrain Manual*. Yuma, AZ.: Marine Aviation Weapons and Tactics Squadron One, March 1999.

Usry, Maj Floyd J. and Maj Matthew T. Sampson. "MAWTS-1 Urban CAS Initiatives." *Marine Corps Gazette* (May 1999): pp. 33–36.

Vick, Alan et al. *Aerospace Operations in Urban Environments*. Santa Monica, CA: RAND Corporation, 2000.

Vick, Alan et al. *Enhancing Air Powers Contribution Against Light Infantry Targets*. Santa Monica, CA: RAND Corporation, 1996.

Combined Arms; Armor

Allen, LtCol Travis M. (USMC). *Protection Our Own: Fire Support in Urban Limited Warfare*. Carlisle Barracks, PA: US Army War College, March 1999.

Bell, MajGen B. B. "Armor Branch's 'Way Ahead' Advances on Four Thrust Lines." *Armor* (July–August 2001): pp. 5–6.

Daniels, Capt. James B. "Mechanized Forces in MOUT: M113 Lessons from Operation *Just Cause*." *Infantry* (May–June 1996): pp. 8–11.

Grau, Lester W. "Russian-Manufactured Armored Vehicle Vulnerability in Urban Combat: The Chechnya Experience." *Red Thrust Star* (January 1997): pp. 16–19.

Harding, 1Lt. Ethan H. "Urban Tank Employment Proposal for the 21st Century." *Marine Corps Gazette* (December 1999): pp. 37–39.

Klug, Capt. J. P. "Armor's Role in Future US MOUT Doctrine." *Armor* (May–June 2000): pp. 7–11.

Lamont, LtCol. R. W. (USMC). "Tale of Two Cities – Hue and Khorramshahr." *Armor* (May–June 1999): pp. 24–26.

Miles, Capt. John L. III and Capt. Mark E. Shankle. "Bradleys in the City." *Infantry* (May–June 1996): p.6–8.

Partridge, Sergeant First Class Ira L. "Deployable versus Survivable." *Armor* (March–April 2001): pp. 12 ff.

Partridge, Sergeant First Class Ira L. "Modifying the Abrams Tank for Fighting in Urban Areas." *Armor* (July–August 2001): pp. 19–24.

Schenking, Captain Scott. "Cavalry Operations in MOUT." *Armor* (March–April 2001): pp. 15–17.

Sherman, Major Frank. "Operation Just Cause: The Armor-Infantry Team in the Close Fight." *Armor* (September–October 1996): pp. 34–35.

Warford, Jim. "The Resurrection of Russian Armor: Surprises from Siberia." *Armor* (September–October 1998): pp. 30–33.

C4ISR; Leadership

Bowers, Capt. William J. "Leadership from the Front." *Proceedings* (June 1999): pp. 48–50.

Gerwehr, Scott and Russell W. Glenn. *The Art of Darkness*. Santa Monica, CA: RAND Corporation, 2000.

Grau, Lester W. "Urban Warfare Communications: A Contemporary Russian View." *Red Thrust Star* (July 1996): pp. 5–10.

Marine Corps Intelligence Activity. *Urban Generic Information Requirements Handbook*. Quantico, VA: US Marine Corps, 1998.

Row, Maj. Lisa A. "Through the Maelstrom of Three-Block War: Who Shall Lead the Marines?" *Marine Corps Gazette* (September 1999): pp. 40–43.

Schnaubelt, Christopher M. "Lessons in Command and Control from the Los Angeles Riots." *Parameters* (Summer 1997): pp. 88–109.

Smith, LtCol. Michael M. (USAR) and Maj. Melinda Hofstetter (USMC). "Conduit or Cul-de-Sac? Information Flow in Civil-Military Operations." *Joint Forces Quarterly* (Spring 1999): pp. 100–105.

US Department of Defense, Joint Staff, Joint C4ISR Decision Support Center. *Urban ISR Study*. June 2000. SECRET/NOFORN.

US Department of Defense, Joint Staff. *Military Operations in Urban Terrain C^4I Study*. Washington, DC: US Government Printing Office, October 1999.

Doctrine

Crabb, Capt. Andrew L. "Urban Patrolling Doctrine: Missing In Action?" *Marine Corps Gazette* (August 1997): pp. 28–31.

US Department of the Army. *An Infantryman's Guide to Urban Combat*, Field Manual 90-10-1. Washington, DC: US Government Printing Office, 1993.

US Department of Defense, Chairman, Joint Chiefs of Staff. *Joint Vision 2020*. Washington, DC: US Government Printing Office, 2000.

US Department of Defense, Joint Staff. *Doctrine for Joint Urban Operations,* Joint Publication 3-06. 2000.

US Department of Defense, Joint Staff. *Handbook for Joint Urban Operations*. Washington, DC: US Government Printing Office, 2000.

Experimentation

Gangle, Col. Randolph A. (USMC, ret.). "The Foundation for Urban Warrior." *Marine Corps Gazette* (July 1998): pp. 52–54.

Kelly, Maj. John F. "Simulation Support for the URBAN WARRIOR Advanced Warfighting Experiment." *Marine Corps Gazette* (January 2000): pp. 39–41.

US Marine Corps Warfighting Laboratory. *Project Metropolis: Military Operations on Urbanized Terrain Battalion Level Experiments—Experiment After Action Report*. February 2001.

Van Riper, LtGen Paul K. (USMC). "A Concept for Future Military Operations on Urbanized Terrain." *Marine Corps Gazette* (October 1997): pp. A1–A6.

General

Cooling, Maj. Norman, L. (USMC). "Creating the Conditions Needed to Win the Street Fight." *Marine Corps Gazette* (January 2002): pp. 54–68.

Fitzgerald, Carol J. "Changing the Face of Urban Warfare." *Armed Forces Journal International* (February 2001): pp. 18–19.

Gilbert, Adrian. *Stalk and Kill*. New York: St. Martin's Press, 1997.

Glenn, Russell W., ed. *The City's Many Faces*. Santa Monica, CA: RAND Corporation, 2000.

Glenn, Russell W., ed. *Combat in Hell*. Santa Monica, CA: RAND Corporation, 1996.

Glenn, Russell W., ed. "Fox Trot: Seeking Preparedness for Military Urban Operations." *Armed Forces Journal International* (May 1999): pp. 46–49.

Glenn, Russell W., ed. *Heavy Matter*. Santa Monica, CA: RAND Corporation, 2000.

Glenn, Russell W., ed. *Marching Under Darkening Skies*. Santa Monica, CA: RAND Corporation, 1998.

Glenn, Russell W., ed. '…*We Band of Brothers*.' Santa Monica, CA: RAND Corporation, 1999.

Glenn, Russell W., et al. *Denying the Widow-Maker*. Santa Monica, CA: RAND Corporation, 1998.

Greene, Capt. Stephen J. "MOOTW: Fighting the Close Quarter Battle." *Marine Corps Gazette* (September 1996): pp. 85–86.

Groves, Brig. Gen. John R. (Kentucky National Guard). "Operations in Urban Environments." *Military Review* (July–Aug 1998): pp. 31–40.

Hahn, Robert F. II and Bonnie Jezior. "Urban Warfare and the Urban Warfighter of 2025." *Parameters* (Summer 1999): pp. 74–86.

Hasenauer, Heike. "F/X for Urban Warfare." *Soldiers* (June 1998).

Heal, CWO-5 Sid (USMC Reserve). "Crowds, Mobs and Nonlethal Weapons." *Military Review* (March–April 2000): pp. 45–50.

Herbert, Dennis B. "Non-Lethal Weaponry: From Tactical to Strategic Applications." *Joint Forces Quarterly* (Spring 1999): pp. 87–91.

Hurley, William J. *Taking the "Revolution in Military Affairs" Downtown: New Approaches to Urban Operations*. Alexandria, VA: Institute for Defense Analyses, IDA Paper P-3593, August 2001.

Hurley, William J., ed. *Workshop on Advanced Technologies for Urban Operations, November 14-15, 2000, Held at the Institute for Defense Analyses, Alexandria, Virginia: Summary of Proceedings*. Alexandria, VA: Institute for Defense Analyses, IDA Document D-2574, June 2001.

Lasswell, Col. James A. "Wall to Wall." *Armed Forces Journal International* (January 1998): pp. 36-39.

Marine Corps Intelligence Activity. *The Urban Century: Developing World Urban Trends and Possible Factors Affecting Military Operations*. Quantico, VA: US Marine Corps, 1997.

McCleskey, Maj. Edward R. (USAF). *Urban Warfare at the Operational Level: Identifying Centers of Gravity and Key Nodes*. Maxwell AFB, AL: US Air Force Air University Air Command and Staff College, April 1999.

National Ground Intelligence Center. *How They Fight: Armies of the World, MOUT—Worldwide*. Vol. 4-01. Charlottesville, VA: NGIC, August 2001.

Packard, Capt. Scott E. "Bottom Line: It's Infantry." *Proceedings* (November 1998): pp. 28–31.

Peters, Ralph. "The Human Terrain of Urban Operations." *Parameters* (Spring 2000): pp. 4–12.

Peters, Ralph. "Our Soldiers, Their Cities." *Parameters* (Spring 1996): pp. 43–50.

Podlesny, Robert E. "MOUT: The Show Stopper." *Proceedings* (February 1998): pp. 50-54.

Press, Daryl G. "Urban Warfare: Options, Problems, and the Future." *Marine Corps Gazette* (April 1999): pp. 14–18.

Reed, Fred V. "City Slickers Become Targets of Future Marine Corps Operations." *Signal* (July 1998): pp. 49–53.

Reed, Fred V. "Marines Seek New Solutions to Secure the Urban Arena." *Signal* (June 1999): pp. 99–102.

Scales, Maj. Gen. Robert H. Jr. (USA). "The Indirect Approach." *Armed Forces Journal International* (October 1998): pp. 68–74.

Spiller, Roger J. *Sharp Corners: Urban Operations at Century's End*. Ft. Leavenworth, KS: US Army Command and Staff College Press, 2000.

Steele, Dennis. "Mounting Siege on Urban Warfare: Creating Technology for Kicking in the Door." *Army* (January 2000): pp. 31–36.

Stewart, Jeb. "Engineers, Army After Next, and Military Operations in Urban Terrain." *Engineer* (March 1999): pp. 17–19.

Strader, Capt. O. Kent. "Counterinsurgency in an Urban Environment." *Infantry* (January–February 1997): pp. 8–11.

Tuozzolo, Col. John J. (USAR). "The Challenge of Civil-Military Operations." *Joint Forces Quarterly* (Summer 1997): pp. 54–58.

US Department of Defense, Defense Science Board. *1998 Summer Study Joint Operations Superiority in the 21st Century, Integrating Capabilities Underwriting Joint Vision 2010 and Beyond*. October 1998.

US Department of Defense, Defense Science Board. *1996 Summer Study Task Force on Tactics and Technology for 21st Century Military Superiority*. October 1996.

US Department of Defense, Defense Science Board. *Report of the DSB Task Force on 1994 Summer Study on Military Operations in Built-Up Areas (MOBA)*. November 1994.

US Department of Defense, Defense Science Board. *Conflict Environment Task Force (Implications of Third World Urban Involvement)*. May 1986.

US Department of Defense, Defense Science Board. *1984 DSB Summer Study on Urban Warfare*. 1984.

US Department of Defense. *Joint Warfighting Science and Technology Plan*. Washington, DC: US Government Printing Office, 2001.

US Department of Defense, Joint Non-Lethal Weapons Directorate. *Non-Lethal Weapons Joint Mission Area Analysis/Joint Mission Need Analysis: Final Report*. Washington, DC: US Government Printing Office, December 2000.

US Department of Defense, Joint Staff. *Joint Warfighting Capabilities Assessment: Phase One Urban Operations Study*. Washington, DC: US Government Printing Office, 1999.

US General Accounting Office. *Military Capabilities: Focused Attention Needed to Prepare US Forces for Combat in Urban Areas*. Washington, DC: US Government Printing Office, 2000.

Valceanu, SSG John. "Concrete Combat." *Soldiers* (June 1999).

Willingham, Stephen. "Marine Technology Dollars to Focus on Urban Combat." *National Defense* (December 1999): pp. 20–21.

Willingham, Stephen. "US Unprepared for Urban Warfare, Analysts Caution." *National Defense* (April 2000): p. 33.

Worley, D. Robert, Alec Wahlman, and Dennis J. Gleeson, Jr. *Military Operations in Urban Terrain: A Survey of Journal Articles*. Alexandria, VA: Institute for Defense Analyses, IDA Document D-2521, October 2000.

History

Ackerman, Robert K. "Echoes of Chechnya Warfare Resound in Moscow, Quantico." *Signal* (May 2000): pp. 39–42.

Aldis, Anne, ed. *The Second Chechen War*. Occasional Paper No. 40. Shrivenham, UK: Strategic and Combat Studies Institute, 2000.

Bowden, Mark. *Black Hawk Down*. New York: Penguin, 1999.

Boyko, Maj Robert G. "Just Cause MOUT Lessons Learned." *Infantry* (May–June 1991): pp. 28–32.

Brown, Capt. Kevin W. "The Urban Warfare Dilemma—US Casualties vs. Collateral Damage." *Marine Corps Gazette* (January 1997): pp. 38–40.

Casey, Captain Ken. "Urban Combat in World War II." *Armor* (November–December 1999): pp. 8-13.

Celestan, Maj. Gregory J. "Red Storm: The Russian Artillery in Chechnya." *Field Artillery* (January–February 1997): pp. 42–45.

English, John A. and Bruce I. Gudmundsson. *On Infantry*. Westport, CT: Praeger, 1994.

Grau, Lester W. "Russian Urban Tactics: Lessons from the Battle for Grozny." *INSS Strategic Forum* (July 1995).

Grau, Lester W. "The RPG-7 On the Battlefields of Today and Tomorrow." *Infantry* (May–August 1998): pp. 6–8.

Grau, Lester W. (USA, ret.) and Jacob W. Kipp. "Urban Combat: Confronting the Specter." *Military Review* (July–August 1999): pp. 9–17.

Grau, Lester W. and Timothy Smith. "A Crushing Victory: Fuel-Air Explosives and Grozny 2000." *Marine Corps Gazette* (August 2000): pp. 30–33.

Hollis, Capt. Mark A. B. "Platoon Under Fire: Mogadishu, October 1993." *Infantry* (January–April 1998): pp. 27–34.

Jalali, Ali A. and Lester W. Grau. "Night Stalkers and the Mean Streets: Afghan Urban Guerrillas." *Infantry* (January–April 1999): pp. 20–26.

Lamont, LtCol. R. W. (USMC). "Urban Warrior—A View from North Vietnam." *Marine Corps Gazette* (April 1999): pp. 32–33.

Leaf, Capt. James D. "MOUT and the 1982 Lebanon Campaign: The Israeli Approach." *Armor* (July–August 2000): pp. 8–11.

Lieven, Anatol. "The World Turned Upside Down." *Armed Forces Journal International* (August 1998): pp. 40-43.

Marine Corps Intelligence Activity. *Urban Warfare Study: City Case Studies Compilation*. Quantico, VA: US Marine Corps, 1999.

Mendel, Col. William (US Army, ret.). "Operation Rio: Taking Back the Streets." *Military Review* (May–June 1997).

Murray, Williamson. "Thinking About Cities and War." *Marine Corps Gazette* (July 2000): pp. 38–40.

Murray, Williamson. *War and Urban Terrain in the Twenty-First Century*. Alexandria, VA: Institute for Defense Analyses, IDA Paper P-3568, November 2000.

Murray, Williamson, and Allan R. Millett. *A War to be Won*. Cambridge, MA: Belknap Press, 2000.

Orr, Michael J. "The New Year's Eve Attack on Grozny." *Red Thrust Star* (July 1996).

Reed, 1Lt James. "The Chechen War: Part III." *Red Thrust Star* (October 1996).

Rupe, Capt. Chad A. "The Battle for Grozny." *Armor* (May–June 1999): 20 ff.

Tellier, Capt Jon E. "The Battle for Hue." *Infantry* (July–August 1995): pp. 21–26.

Thomas, Timothy L. "The Battle of Grozny: Deadly Classroom for Urban Combat." *Parameters* (Summer 1999): pp. 87–102.

Thomas, Timothy L. "The Caucasus Conflict and Russian Security: the Russian Armed Forces Confront Chechnya III. The Battle for Grozny, 1-26 January 1995." *The Journal of Slavic Military Studies* (March 1997): pp. 50–108.

Thomas, Timothy L. "Grozny 2000: Urban Combat Lessons Learned." *Military Review* (July–August 2000): pp. 50-58.

Thomas, Timothy L. and LtCol. Lester W. Grau (USA, ret.). "Russian Lessons Learned from the Battles for Grozny." *Marine Corps Gazette* (April 2000): pp. 45–48.

Thomas, Timothy L. and Major Charles P. O'Hara. "Combat Stress in Chechnya: The Equal Opportunity Disorder." *Army Medical Department Journal* (January–March 2000).

Wilson, Scott. "Colombian Right's 'Cleaning' Campaign." *The Washington Post*. 17 April 2001. p. A01.

Logistics

Brown, Maj. Kevin W. "The Sustainment Distribution Team—Providing 'Close' Combat Service Support in MOUT." *Marine Corps Gazette* (November 1998): pp. 72-73.

Gbur, LCdr. Charles J. Jr. (USNR). "Battalion Aid Station Support of Military Operations on Urbanized Terrain." *Marine Corps Gazette* (February 1999): pp. 22-25.

Grau, Lester W. and Dr. William A Jorgensen, D.O. "Handling the Wounded in a Counter-Guerrilla War: The Soviet/Russian Experience in Afghanistan and Chechnya." *US Army Medical Department Journal* (January–February 1998).

Grau, Lester W. and Timothy L. Thomas. " 'Soft Log' and Concrete Canyons: Russian Urban Combat Logistics in Grozny." *Marine Corps Gazette* (October 1999): pp. 67-75.

Training

Cameron, Robert S. "It Takes a Village to Prepare for Urban Combat…and Fort Knox is Getting One." *Armor* (November-December 1997): pp. 9-12.

Hammes, LtCol. Thomas X. "Preparing for Today's Battlefield." *Marine Corps Gazette* (July 1997): pp. 56–62.

Hammes, Col. Thomas X. "Time to Get Serious About Urban Warfare Training." *Marine Corps Gazette* (April 1999): pp. 19–21.

Hillyard, Michael J. "The American Military University: Educating Marines for the Three Block War." *Marine Corps Gazette* (December 1999): pp. 54–56.

Hoffman, LtCol. Jon T. (USMCR). Marines Assault the Joint Readiness Training Center." *Marine Corps Gazette* (February 1999): pp. 34–36.

Reynolds, LtCol. John H. (USMC, ret.). "A Case for 21st Century MOUT Facilities." *Marine Corps Gazette* (July 2000): pp. 41–44.

Rouleau, Capt Rich. "Mountain Cavalry Recon in Built-Up Areas." *Armor* (July–August 2001): pp. 16 ff.

Tiron, Roxana. "Army Training Site Brings to Life the Horrors of War." *National Defense* (July 2001): pp. 20–22.

Bibliography, Arranged by Author

Ackerman, Robert K. "Echoes of Chechnya Warfare Resound in Moscow, Quantico." *Signal* (May 2000): pp. 39–42.

Aldis, Anne, ed. *The Second Chechen War*. Occasional Paper No. 40. Shrivenham, UK: Strategic and Combat Studies Institute, 2000.

Allen, LtCol Travis M. (USMC). *Protection Our Own: Fire Support in Urban Limited Warfare*. Carlisle Barracks, PA: US Army War College, March 1999.

Bell, MajGen B. B. "Armor Branch's 'Way Ahead' Advances on Four Thrust Lines." *Armor* (July–August 2001): pp. 5–6.

Bowden, Mark. *Black Hawk Down*. New York: Penguin, 1999.

Bowers, Capt. William J. "Leadership from the Front." *Proceedings* (June 1999): pp. 48–50.

Boyko, Maj Robert G. "Just Cause MOUT Lessons Learned." *Infantry* (May–June 1991): pp. 28–32.

Brown, Capt. Kevin W. "The Urban Warfare Dilemma—US Casualties vs. Collateral Damage." *Marine Corps Gazette* (January 1997): pp. 38–40.

Brown, Maj. Kevin W. "The Sustainment Distribution Team—Providing 'Close' Combat Service Support in MOUT." *Marine Corps Gazette* (November 1998): pp. 72-73.

Cameron, Robert S. "It Takes a Village to Prepare for Urban Combat…and Fort Knox is Getting One." *Armor* (November-December 1997): pp. 9-12.

Casey, Captain Ken. "Urban Combat in World War II." *Armor* (November–December 1999): pp. 8-13.

Celestan, Maj. Gregory J. "Red Storm: The Russian Artillery in Chechnya." *Field Artillery* (January–February 1997): pp. 42–45.

Cooling, Maj. Norman, L. (USMC). "Creating the Conditions Needed to Win the Street Fight." *Marine Corps Gazette* (January 2002): pp. 54–68.

Crabb, Capt. Andrew L. "Urban Patrolling Doctrine: Missing In Action?" *Marine Corps Gazette* (August 1997): pp. 28–31.

Daniels, Capt. James B. "Mechanized Forces in MOUT: M113 Lessons from Operation *Just Cause*." *Infantry* (May–June 1996): pp. 8–11.

English, John A. and Bruce I. Gudmundsson. *On Infantry*. Westport, CT: Praeger, 1994.

Fitzgerald, Carol J. "Changing the Face of Urban Warfare." *Armed Forces Journal International* (February 2001): pp. 18–19.

Gangle, Col. Randolph A. (USMC, ret.). "The Foundation for Urban Warrior." *Marine Corps Gazette* (July 1998): pp. 52–54.

Gbur, LCdr. Charles J. Jr. (USNR). "Battalion Aid Station Support of Military Operations on Urbanized Terrain." *Marine Corps Gazette* (February 1999): pp. 22-25.

Gerwehr, Scott and Russell W. Glenn. *The Art of Darkness*. Santa Monica, CA: RAND Corporation, 2000.

Gilbert, Adrian. *Stalk and Kill*. New York: St. Martin's Press, 1997.

Glenn, Russell W., ed. '…*We Band of Brothers*.' Santa Monica, CA: RAND Corporation, 1999.

Glenn, Russell W., ed. "Fox Trot: Seeking Preparedness for Military Urban Operations." *Armed Forces Journal International* (May 1999): pp. 46–49.

Glenn, Russell W., ed. *Combat in Hell*. Santa Monica, CA: RAND Corporation, 1996.

Glenn, Russell W., ed. *Heavy Matter*. Santa Monica, CA: RAND Corporation, 2000.

Glenn, Russell W., ed. *Marching Under Darkening Skies*. Santa Monica, CA: RAND Corporation, 1998.

Glenn, Russell W., ed. *The City's Many Faces*. Santa Monica, CA: RAND Corporation, 2000.

Glenn, Russell W., et al. *Denying the Widow-Maker*. Santa Monica, CA: RAND Corporation, 1998.

Grau, Lester W. (USA, ret.) and Jacob W. Kipp. "Urban Combat: Confronting the Specter." *Military Review* (July–August 1999): pp. 9–17.

Grau, Lester W. "Russian Urban Tactics: Lessons from the Battle for Grozny." *INSS Strategic Forum* (July 1995).

Grau, Lester W. "Russian-Manufactured Armored Vehicle Vulnerability in Urban Combat: The Chechnya Experience." *Red Thrust Star* (January 1997): pp. 16–19.

Grau, Lester W. "The RPG-7 On the Battlefields of Today and Tomorrow." *Infantry* (May–August 1998): pp. 6–8.

Grau, Lester W. "Urban Warfare Communications: A Contemporary Russian View." *Red Thrust Star* (July 1996): pp. 5–10.

Grau, Lester W. and Dr. William A Jorgensen, D.O. "Handling the Wounded in a Counter-Guerrilla War: The Soviet/Russian Experience in Afghanistan and Chechnya." *US Army Medical Department Journal* (January–February 1998).

Grau, Lester W. and Timothy L. Thomas. " 'Soft Log' and Concrete Canyons: Russian Urban Combat Logistics in Grozny." *Marine Corps Gazette* (October 1999): pp. 67-75.

Grau, Lester W. and Timothy Smith. "A Crushing Victory: Fuel-Air Explosives and Grozny 2000." *Marine Corps Gazette* (August 2000): pp. 30–33.

Greene, Capt. Stephen J. "MOOTW: Fighting the Close Quarter Battle." *Marine Corps Gazette* (September 1996): pp. 85–86.

Groves, Brig. Gen. John R. (Kentucky National Guard). "Operations in Urban Environments." *Military Review* (July–Aug 1998): pp. 31–40.

Hahn, Robert F. II and Bonnie Jezior. "Urban Warfare and the Urban Warfighter of 2025." *Parameters* (Summer 1999): pp. 74–86.

Hammes, Col. Thomas X. "Time to Get Serious About Urban Warfare Training." *Marine Corps Gazette* (April 1999): pp. 19–21.

Hammes, LtCol. Thomas X. "Preparing for Today's Battlefield." *Marine Corps Gazette* (July 1997): pp. 56–62.

Harding, 1Lt. Ethan H. "Urban Tank Employment Proposal for the 21st Century." *Marine Corps Gazette* (December 1999): pp. 37–39.

Hasenauer, Heike. "F/X for Urban Warfare." *Soldiers* (June 1998).

Heal, CWO-5 Sid (USMC Reserve). "Crowds, Mobs and Nonlethal Weapons." *Military Review* (March–April 2000): pp. 45–50.

Herbert, Dennis B. "Non-Lethal Weaponry: From Tactical to Strategic Applications." *Joint Forces Quarterly* (Spring 1999): pp. 87–91.

Hewson, Maj. Harry J. "Light/Attack Helicopter Operations in the Three Block War." *Marine Corps Gazette* (April 1999): pp. 25–27.

Hillyard, Michael J. "The American Military University: Educating Marines for the Three Block War." *Marine Corps Gazette* (December 1999): pp. 54–56.

Hoffman, LtCol. Jon T. (USMCR). Marines Assault the Joint Readiness Training Center." *Marine Corps Gazette* (February 1999): pp. 34–36.

Hollis, Capt. Mark A. B. "Platoon Under Fire: Mogadishu, October 1993." *Infantry* (January–April 1998): pp. 27–34.

Hurley, William J. *Taking the "Revolution in Military Affairs" Downtown: New Approaches to Urban Operations.* Alexandria, VA: Institute for Defense Analyses, IDA Paper P-3593, August 2001.

Hurley, William J., ed. *Workshop on Advanced Technologies for Urban Operations, November 14-15, 2000, Held at the Institute for Defense Analyses, Alexandria, Virginia: Summary of*

Proceedings. Alexandria, VA: Institute for Defense Analyses, IDA Document D-2574, June 2001.

Jalali, Ali A. and Lester W. Grau. "Night Stalkers and the Mean Streets: Afghan Urban Guerrillas." *Infantry* (January–April 1999): pp. 20–26.

Kelly, Maj. John F. "Simulation Support for the URBAN WARRIOR Advanced Warfighting Experiment." *Marine Corps Gazette* (January 2000): pp. 39–41.

Kitfield, James. "War in the Urban Jungles." *Air Force Magazine* (December 1998).

Klug, Capt. J. P. "Armor's Role in Future US MOUT Doctrine." *Armor* (May–June 2000): pp. 7–11.

Lamont, LtCol. R. W. (USMC). "Tale of Two Cities – Hue and Khorramshahr." *Armor* (May–June 1999): pp. 24–26.

Lamont, LtCol. R. W. (USMC). "Urban Warrior—A View from North Vietnam." *Marine Corps Gazette* (April 1999): pp. 32–33.

Lasswell, Col. James A. "Wall to Wall." *Armed Forces Journal International* (January 1998): pp. 36-39.

Leaf, Capt. James D. "MOUT and the 1982 Lebanon Campaign: The Israeli Approach." *Armor* (July–August 2000): pp. 8–11.

Lieven, Anatol. "The World Turned Upside Down." *Armed Forces Journal International* (August 1998): pp. 40-43.

Marine Corps Intelligence Activity. *The Urban Century: Developing World Urban Trends and Possible Factors Affecting Military Operations*. Quantico, VA: US Marine Corps, 1997.

Marine Corps Intelligence Activity. *Urban Generic Information Requirements Handbook*. Quantico, VA: US Marine Corps, 1998.

Marine Corps Intelligence Activity. *Urban Warfare Study: City Case Studies Compilation*. Quantico, VA: US Marine Corps, 1999.

McCleskey, Maj. Edward R. (USAF). *Urban Warfare at the Operational Level: Identifying Centers of Gravity and Key Nodes*. Maxwell AFB, AL: US Air Force Air University Air Command and Staff College, April 1999.

Mendel, Col. William (US Army, ret.). "Operation Rio: Taking Back the Streets." *Military Review* (May–June 1997).

Miles, Capt. John L. III and Capt. Mark E. Shankle. "Bradleys in the City." *Infantry* (May–June 1996): p.6–8.

Murray, Williamson, and Allan R. Millett. *A War to be Won*. Cambridge, MA: Belknap Press, 2000.

Murray, Williamson. "Thinking About Cities and War." *Marine Corps Gazette* (July 2000): pp. 38–40.

Murray, Williamson. *War and Urban Terrain in the Twenty-First Century.* Alexandria, VA: Institute for Defense Analyses, IDA Paper P-3568, November 2000.

National Ground Intelligence Center. *How They Fight: Armies of the World, MOUT—Worldwide.* Vol. 4-01. Charlottesville, VA: NGIC, August 2001.

Orr, Michael J. "The New Year's Eve Attack on Grozny." *Red Thrust Star* (July 1996).

Packard, Capt. Scott E. "Bottom Line: It's Infantry." *Proceedings* (November 1998): pp. 28–31.

Partridge, Sergeant First Class Ira L. "Deployable versus Survivable." *Armor* (March–April 2001): pp. 12 ff.

Partridge, Sergeant First Class Ira L. "Modifying the Abrams Tank for Fighting in Urban Areas." *Armor* (July–August 2001): pp. 19–24.

Peters, Ralph. "Our Soldiers, Their Cities." *Parameters* (Spring 1996): pp. 43–50.

Peters, Ralph. "The Human Terrain of Urban Operations." *Parameters* (Spring 2000): pp. 4–12.

Podlesny, Robert E. "MOUT: The Show Stopper." *Proceedings* (February 1998): pp. 50-54.

Press, Daryl G. "Urban Warfare: Options, Problems, and the Future." *Marine Corps Gazette* (April 1999): pp. 14–18.

Reed, 1Lt James. "The Chechen War: Part III." *Red Thrust Star* (October 1996).

Reed, Fred V. "City Slickers Become Targets of Future Marine Corps Operations." *Signal* (July 1998): pp. 49–53.

Reed, Fred V. "Marines Seek New Solutions to Secure the Urban Arena." *Signal* (June 1999): pp. 99–102.

Reynolds, LtCol. John H. (USMC, ret.). "A Case for 21st Century MOUT Facilities." *Marine Corps Gazette* (July 2000): pp. 41–44.

Rose, Col. Daniel R., Maj. Eric F. Buer, and Capt. Patrick S. McDoniel. "Close Air Support Ranges for the Urban Warrior." *Marine Corps Gazette* (May 2000): pp. 69–72.

Rouleau, Capt Rich. "Mountain Cavalry Recon in Built-Up Areas." *Armor* (July–August 2001): pp. 16 ff.

Row, Maj. Lisa A. "Through the Maelstrom of Three-Block War: Who Shall Lead the Marines?" *Marine Corps Gazette* (September 1999): pp. 40–43.

Rupe, Capt. Chad A. "The Battle for Grozny." *Armor* (May–June 1999): 20 ff.

Scales, Maj. Gen. Robert H. Jr. (USA). "The Indirect Approach." *Armed Forces Journal International* (October 1998): pp. 68–74.

Schenking, Captain Scott. "Cavalry Operations in MOUT." *Armor* (March–April 2001): pp. 15–17.

Schnaubelt, Christopher M. "Lessons in Command and Control from the Los Angeles Riots." *Parameters* (Summer 1997): pp. 88–109.

Schwartz, Lt. Gen. Norton A. (USAF) and Col. Robert B. Stephan (USAF). "Don't Go Downtown without Us." *Aerospace Power Journal* (Spring 2000): pp. 3–11.

Sherman, Major Frank. "Operation Just Cause: The Armor-Infantry Team in the Close Fight." *Armor* (September–October 1996): pp. 34–35.

Smith, LtCol. Michael M. (USAR) and Maj. Melinda Hofstetter (USMC). "Conduit or Cul-de-Sac? Information Flow in Civil-Military Operations." *Joint Forces Quarterly* (Spring 1999): pp. 100–105.

Spiller, Roger J. *Sharp Corners: Urban Operations at Century's End*. Ft. Leavenworth, KS: US Army Command and Staff College Press, 2000.

Steele, Dennis. "Mounting Siege on Urban Warfare: Creating Technology for Kicking in the Door." *Army* (January 2000): pp. 31–36.

Stewart, Jeb. "Engineers, Army After Next, and Military Operations in Urban Terrain." *Engineer* (March 1999): pp. 17–19.

Strader, Capt. O. Kent. "Counterinsurgency in an Urban Environment." *Infantry* (January–February 1997): pp. 8–11.

Tellier, Capt Jon E. "The Battle for Hue." *Infantry* (July–August 1995): pp. 21–26.

Thomas, Timothy L. "Air Operations in Low Intensity Conflict: the Case of Chechnya." *Airpower Journal* (Winter 1997): pp. 51–59.

Thomas, Timothy L. "Grozny 2000: Urban Combat Lessons Learned." *Military Review* (July–August 2000): pp. 50-58.

Thomas, Timothy L. "The Battle of Grozny: Deadly Classroom for Urban Combat." *Parameters* (Summer 1999): pp. 87–102.

Thomas, Timothy L. "The Caucasus Conflict and Russian Security: the Russian Armed Forces Confront Chechnya III. The Battle for Grozny, 1-26 January 1995." *The Journal of Slavic Military Studies* (March 1997): pp. 50–108.

Thomas, Timothy L. and LtCol. Lester W. Grau (USA, ret.). "Russian Lessons Learned from the Battles for Grozny." *Marine Corps Gazette* (April 2000): pp. 45–48.

Thomas, Timothy L. and Major Charles P. O'Hara. "Combat Stress in Chechnya: The Equal Opportunity Disorder." *Army Medical Department Journal* (January–March 2000).

Tiron, Roxana. "Army Training Site Brings to Life the Horrors of War." *National Defense* (July 2001): pp. 20–22.

Tuozzolo, Col. John J. (USAR). "The Challenge of Civil-Military Operations." *Joint Forces Quarterly* (Summer 1997): pp. 54–58.

US Department of Defense, Chairman, Joint Chiefs of Staff. *Joint Vision 2020*. Washington, DC: US Government Printing Office, 2000.

US Department of Defense, Defense Science Board. *1984 DSB Summer Study on Urban Warfare*. 1984.

US Department of Defense, Defense Science Board. *1996 Summer Study Task Force on Tactics and Technology for 21st Century Military Superiority*. October 1996.

US Department of Defense, Defense Science Board. *1998 Summer Study Joint Operations Superiority in the 21st Century, Integrating Capabilities Underwriting Joint Vision 2010 and Beyond*. October 1998.

US Department of Defense, Defense Science Board. *Conflict Environment Task Force (Implications of Third World Urban Involvement)*. May 1986.

US Department of Defense, Defense Science Board. *Report of the DSB Task Force on 1994 Summer Study on Military Operations in Built-Up Areas (MOBA)*. November 1994.

US Department of Defense, Joint Non-Lethal Weapons Directorate. *Non-Lethal Weapons Joint Mission Area Analysis/Joint Mission Need Analysis: Final Report*. Washington, DC: US Government Printing Office, December 2000.

US Department of Defense, Joint Staff, Joint C4ISR Decision Support Center. *Urban ISR Study*. June 2000. SECRET/NOFORN.

US Department of Defense, Joint Staff. *Doctrine for Joint Urban Operations,* Joint Publication 3-06. 2002.

US Department of Defense, Joint Staff. *Handbook for Joint Urban Operations*. Washington, DC: US Government Printing Office, 2000.

US Department of Defense, Joint Staff. *Joint Warfighting Capabilities Assessment: Phase One Urban Operations Study*. Washington, DC: US Government Printing Office, 1999.

US Department of Defense, Joint Staff. *Military Operations in Urban Terrain C^4I Study*. Washington, DC: US Government Printing Office, October 1999.

US Department of Defense. *Joint Warfighting Science and Technology Plan*. Washington, DC: US Government Printing Office, 1999.

US Department of Defense. *Report to Congress: Kosovo/Operation Allied Force After-Action Report*. Washington: US Government Printing Office, 2000.

US Department of the Army. *An Infantryman's Guide to Urban Combat*, Field Manual 90-10-1. Washington, DC: US Government Printing Office, 1993.

US General Accounting Office. *Military Capabilities: Focused Attention Needed to Prepare US Forces for Combat in Urban Areas*. Washington, DC: US Government Printing Office, 2000.

US Marine Corps Warfighting Laboratory. *Project Metropolis: Military Operations on Urbanized Terrain Battalion Level Experiments—Experiment After Action Report*. February 2001.

US Marine Corps. Marine Aviation Weapons and Tactics Squadron One. *Aviation Combat Element: Military Operations on Urban Terrain Manual*. Yuma, AZ.: Marine Aviation Weapons and Tactics Squadron One, March 1999.

Usry, Maj Floyd J. and Maj Matthew T. Sampson. "MAWTS-1 Urban CAS Initiatives." *Marine Corps Gazette* (May 1999): pp. 33–36.

Valceanu, SSG John. "Concrete Combat." *Soldiers* (June 1999).

Van Riper, LtGen Paul K. (USMC). "A Concept for Future Military Operations on Urbanized Terrain." *Marine Corps Gazette* (October 1997): pp. A1–A6.

Vick, Alan et al. *Aerospace Operations in Urban Environments*. Santa Monica, CA: RAND Corporation, 2000.

Vick, Alan et al. *Enhancing Air Powers Contribution Against Light Infantry Targets*. Santa Monica, CA: RAND Corporation, 1996.

Warford, Jim. "The Resurrection of Russian Armor: Surprises from Siberia." *Armor* (September–October 1998): pp. 30–33.

Willingham, Stephen. "Marine Technology Dollars to Focus on Urban Combat." *National Defense* (December 1999): pp. 20–21.

Willingham, Stephen. "US Unprepared for Urban Warfare, Analysts Caution." *National Defense* (April 2000): p. 33.

Wilson, Scott. "Colombian Right's 'Cleaning' Campaign." *The Washington Post*. 17 April 2001. p. A01.

Worley, D. Robert, Alec Wahlman, and Dennis J. Gleeson, Jr. *Military Operations in Urban Terrain: A Survey of Journal Articles*. Alexandria, VA: Institute for Defense Analyses, IDA Document D-2521, October 2000.

Appendix D. Glossary

3D	three dimensional
AAV	amphibious assault vehicle
ACTD	Advanced Concept Technology Demonstration
AD-P	Area Denial to Personnel
ADS	Active Denial System
AD-V	Area Denial to Vehicles
AF	Air Force
AFB	Air Force Base
AJCS	Adaptive Joint Command and Control
ALSA	Air Land Sea Application
AOACMT	Attack Operations Against Critical Mobile Targets
ASD	Assistant Secretary of Defense
AT&L	Acquisition, Technology, and Logistics (Office of the Under Secretary of Defense)
ATDs	Advanced Technology Demonstrations
ATO	Air Tasking Order
BDA	battle damage assessment
BRAC	Base Realignment and Closure
C2W	Control warfare
C3	command, control, and communications
C3I	command, control, communications, and intelligence
C4	command, control, communications, and computers
C4ISR	command, control, communications, computers, intelligence, surveillance, and
CACTF	Combined Arms Collective Training Facilities
CALCM	Conventional Air Launched Cruise Missile
CAMTF	Combined Arms Military Operations on Urbanized Terrain (MOUT) Task Force
CAPT	Captain, Navy
CAS	Close Air Support
CAT	Computer-aided tomography
CC	Crowd Control
CDC	Crowd Dispersal Cartridge
CENTCOM	Central Command (US)
CEP	Concept Exploration Program; Circular Error Probability
CETO	Center for Emerging Threats and Opportunities
CFAC	Clear Facilities
CIMIC	Civil Military Cooperation
CINC	commander in chief

CJCS	Chairman, Joint Chiefs of Staff
CJCSM	Chairman, Joint Chiefs of Staff Manual
CMO	Civil Military Operations
CMOC	Civil-Military Operations Task Force or Civil-Military Operations Center
COL	Colonel, Army
Col	Colonel, Marine Corps
COMINT	Communications Intelligence
CROP	Common Relevant Operational Picture
CSS	Combat Service Support
CTEIP	Central Test and Evaluation Investment Program
CTF	Collective Training Facilities
DARPA	Defense Advanced Research Projects Agency
DASD RP&CP	Deputy Assistant Secretary of Defense for Requirements, Plans, and Counter-Proliferation
DIA MOBA	Defense Intelligence Agency Military Operations in Built-Up Area
DIUWG	Defense Intelligence Urban Working Group
DJ8	Joint Staff Director for Force Structure, Resources and Assessment
DoD	Department of Defense
D-O-T-L-S	Doctrine, Organization, Training, Leadership, Soldiers
DOTMLPF	Doctrine, Organization, Training, Materiel, Leadership, People, Facilities
DPG	Defense Planning Guidance
DSB	Defense Science Board
DSC	Decision Support Center
D-T-L-O-M-S	Doctrine, Organization, Training, Leadership, Materiel, Soldiers
DTTSG	Defense Test and Training Steering (Group)
ELB	Extend the Littoral Battlespace
EMP	electro-magnetic pulse
EO/IR	electro-optical/infrared
ERGM	Extended Range Guided Munition
FFRDCs	Federally Funded Research and Development Centers
FYDP	Future Year Defense Plan
GAO	General Accounting Office
GPS	Global Positioning System
GVS	Ground vehicle system
HITL	human-in-the-loop
HUMINT	Human Intelligence
IADS	Integrated Air Defense System

IC	Intelligence Community
IDA	Institute for Defense Analyses
IFFN	the identification of friend, foe, and/or neutral
IGO	international governmental organizations
INCAP	Incapacitate Personnel
INS	Inertial Navigation System
IPB	Intelligence Preparation of the Battlespace
IR	infrared
IRCM	Infrared countermeasures
ISR	intelligence, surveillance, and reconnaissance
IUSS	Integrated Unit Simulation System
J8	Joint Staff
JASSM	Joint Air To Surface Standoff Missile
JAWP	Joint Advanced Warfighting Program
JCATS	Joint Conflict and Tactical Simulation
JCLL	Joint Center for Lessons Learned
JDAM	Joint Direct Attack Munition
JFC	Joint Force Commander
JFLs	Joint Futures Labs
JIMP	Joint Implementation Plan
JIP	Joint Interactive Planning
JMAA/JMNA	Joint Mission Area Analysis and Joint Mission Need Analysis
JNLWD	Joint NLW Directorate
JPME	Joint Professional Military Education
JRB	Joint Requirements Board
JROC	Joint Requirements Oversight Council
JSIMS	Joint Simulation and Integrated Modeling System
JSOW	Joint Standoff Weapon
JTF	Joint Task Force
JTS	Joint Training System
JTTRR	Joint Test and Training Range Roadmap
JUOSSG	Joint Urban Operations Self Study Group
JUOWG	Joint Urban Operations Working Group
JUWG	Joint Urban Working group
JV2010	Joint Vision 2010
JVB	Joint Virtual Battlespace
JWAC	Joint Warfare Analysis Center
JWARS	Joint Warfare Simulation
JWCA	Joint Warfighting Capabilities Assessment

JWSTP	Joint Warfighting Science and Technology Plan
LAV	light armored vehicle
LFX	live-fire experiences
LOCPAD	Low-Cost Persistent Area Dominance Miniature Missile
LTA	Limited Technical Analysis
LTC	Lieutenant Colonel, Army
LtCol	Lieutenant Colonel, Marine Corps
M	million (of dollars)
M&S	modeling and simulation
MACOMS	Major Army Commands
MAGTF	Marine Air-Ground Task Force
MAJ	Major, Army
Maj	Major, Marine Corps
MASINT	Measurement/Measuring and Signature Intelligence
MAWTS-1	Marine Aviation Weapons Training Squadron-1
MCAS	Marine Corps Air Station
MCIA	Marine Corps Intelligence Activity
MCWL	Marine Corps Warfighting Laboratory
METL	Mission Essential Tasks List
MEU	Marine Expeditionary Unit
MNA	Missions Needs Analysis
MOE	measures of effectiveness
MOOTW	Military Operations Other Than War
MOUT	Military Operations on Urbanized Terrain
MSI/HIS	Multispectral and Hyperspectral Imaging
MTW	Major Theater War
NATO	North Atlantic Treaty Organization
NBC	nuclear-biological-chemical
NDP	National Defense Panel
NDU	National Defense University
NEO	Noncombatant Evacuation Operation
NETEX	NETworks in the Extreme
NGIC	National Group Intelligence Center
NGO	non-governmental organization
NIMA	National Imagery and Mapping Agency
NLSF	Non-Lethal Slippery Foam
NLW	non-lethal weapons
NSPD	National Security Presidential Directive

NSS	National Security Strategy
OB	order of battle
OICW	Objective Individual Combat Weapon
OPFOR	opposition/opposing force
OPLAN	operation plan
OPTEMPO	operation tempo
OSD	Office of the Secretary of Defense
OUSD	Office of the Under Secretary of Defense
P&R	Personnel and Readiness
PACOM	Pacific Command (US)
PEP	Pulsed Energy Projectile
PERSTEMPO	personnel tempo
PME	Professional Military Education
POC	point of contact
POI	Program of Instruction
POMs	Service Program Objective Memoranda
PVO	private voluntary organizations
QDR	Quadrennial Defense Review
R&D	Research & Development
RDO	Rapid Decisive Operations
RF	radio frequency
RMA	Revolution in Military Affairs
ROE	Rules of Engagement
RSTA	Reconnaissance, Surveillance, and Target Acquisition
S&T	Science and Technology
SAE	Special Area of Emphasis
SDB	Small Diameter Bomb
SIGINT	Signal Intelligence
SOCOM	Special Operations Command
SOF	special operations forces
STOW	Synthetic Theater of War
TBM	Theater Ballistic Missile
TIRIC	Training Instrumentation Resource Investment Committee
TRAC	US Army Training and Doctrine Command Analysis Center
TRADOC	Training and Doctrine Command
TTP	tactics, techniques, and procedures

UAV	unmanned aerial vehicle
UCAS	Urban Close Air Support
UCAV	Unmanned Combat Air Vehicle
UJTL	Universal Joint Task List
UK	United Kingdom
UPP	Unmanned Powered Parafoil
US/U.S.	United States
USA	US Army
USAF	US Air Force
USAIS	US Army Infantry School
USECT	Understand, Shape, Engage, Consolidate, Transition
USMC	US Marine Corps
USN	US Navy
USR	Unit Status Report
UWG	Urban Working Group
UXO	Unexploded Ordnance
WMD	weapon of mass destruction

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. **PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.**

1. REPORT DATE (DD-MM-YY)	2. REPORT TYPE	3. DATES COVERED (From – To)
March 2002	Study (Final)	

4. TITLE AND SUBTITLE

Department of Defense Roadmap for Improving Capabilities for Joint Urban Operations. Vol. I: Main Report

5a. CONTRACT NO.

DASW01-98-C-0067

5b. GRANT NO.

5c. PROGRAM ELEMENT NO(S).

6. AUTHOR(S)

William J. Hurley, task leader; Alec Wahlman; COL Thomas Sward, USMC; Duane Schattle; and Joel B. Resnick

5d. PROJECT NO.

5e. TASK NO.

AI-8-1627

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Joint Advanced Warfighting Program/Institute for Defense Analyses
4850 Mark Center Drive
Alexandria, VA 22311-1882

8. PERFORMING ORGANIZATION REPORT NO.

IDA Paper P-3643

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Deputy Under Secretary of Defense for Advanced Systems & Concepts
Office of the Under Secretary of Defense for Acquisition, Technology, & Logistics
Room 3D833, 3700 Defense Pentagon
Washington, DC 20301-3700

10. SPONSOR'S / MONITOR'S ACRONYM(S)

UDSD (AS&C), OUSD (AT&L)

11. SPONSOR'S / MONITOR'S REPORT NO(S).

12. DISTRIBUTION / AVAILABILITY STATEMENT

FOR OFFICIAL USE ONLY. Distribution authorized to U.S. Government agencies only per DoD Directive 5205.2; FOIA Exemption 2 applies. Other requests must be referred to Deputy Under Secretary of Defense for Advanced Systems and Concepts, Office of the Under Secretary for Defense for Acquisition, Technology, and Logistics): November 26, 2002.

13. SUPPLEMENTARY NOTES

Department of Defense Roadmap for Improving Capabilities for Joint Urban Operations. Vol. I: Main Report. Vol. II: MOUT Operational Concepts and Capabilities: The Joint Force Commander's Perspective.

14. ABSTRACT

DoD is striving for major enhancements of joint warfighting capabilities, and military operations on urbanized terrain (MOUT) are a part of that challenge. The challenge is to improve the urban capabilities of current legacy forces, which have been primarily designed for operations in open environments; and to develop new approaches that address the unique demands of urban operations and that hold the promise of dramatic improvement. The Roadmap in this two-volume paper identifies specific directions and initiatives to pursue that can help improve the capabilities of future joint force commanders (JFCs) to conduct urban operations. The JAWP team drew upon the expertise of dozens of individuals from throughout DoD and non-DoD organizations. By taking the perspective of a future JFC, the Roadmap focuses on the joint operational level. However, strategic and tactical levels are also considered.

15. SUBJECT TERMS

Military operations on urbanized terrain (MOUT), urban warfare, urban operations, missions, roadmap, operational capabilities, science and technology, joint force commander (JFC), joint operations, task force, intelligence.

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NO. OF PAGES	19a. NAME OF RESPONSIBLE PERSON
			UU	304	Mrs. Sue C. Payton, Deputy Under Secretary of Defense (Advanced Systems & Concepts)
a. REPORT	b. ABSTRACT	c. THIS PAGE			19b. TELEPHONE NUMBER (Include Area Code)
U	U	U			703.697.6446