

Improving Communications in Urban Warfare

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Of the missions that U.S. military forces must conduct, urban operations are perhaps the most difficult. Compounding their difficulties at the lowest tactical levels, or for infantrymen moving through back alleys and buildings, is the interference caused by buildings and structures that impedes electronic communication. The growing reliance of the U.S. military on "information superiority" underscores the need to address problems of military communication in urban areas.

To speed and ensure better communications, military planners can seek to increase the "supply" of improved communications technologies or to decrease the "demand" for them through changes in tactics, techniques, or procedures. Recent RAND research suggests military planners should address both the "supply" and "demand" for communications in urban operations.

REDUCING COMMUNICATION DEMAND BY CHANGING MILITARY DOCTRINE

Current military doctrine on communications in urban areas focuses on site location, proper training, and other practical considerations such as cover and concealment and avoiding interference. It also discusses alternative means of communication such as the use of wires, messengers, visual and sound signals, and existing commercial infrastructure. This advice should be updated with lessons on how to overcome line-of-sight problems and transmission and reception problems caused by fading and path loss. Organizational changes can also help reduce the demand or need for communications.

Changes in doctrine for better communications should include lessons on the following:

- **Leveraging the urban terrain.** As more soldiers and military vehicles use computers and radios, commanders preparing for urban battle should consider urban terrain from a communications perspective. Soldiers can use high buildings as base stations or relays,

leverage the civilian infrastructure when appropriate, and identify and avoid electromagnetic deadspace. "Obstacle amplification," or placing transmitters so as to take advantage of reflection from buildings or other surfaces, can enhance communication in poorly covered areas.

- **Planning the scheme of maneuver.** Commanders can give greater priority to communications during maneuver in several ways. Avenues of attack can be chosen with consideration for electromagnetic propagation. If primary considerations of cover, concealment, and mission are met, then radios can be positioned away from metallic building infrastructures that might interfere with transmissions. Tactics, techniques, and procedures can be changed for crossing deadspace, which can also be avoided or isolated and left for mop-up operations.
- **Recognizing zones of situational awareness.** Differing zones of urban combat will give troops different levels of awareness of their situation and that of the enemy. Commanders may wish to train their troops to use secondary sets of communication tactics in zones where situational awareness is extremely limited. In close-quarters fighting within buildings, human messengers will be most effective. Between buildings, where most urban combat casualties occur, wireless communications are most needed.
- **Changing coordination mechanisms.** Organizational theory can offer insights on how to reduce the need for communication. Using other means for coordination besides direct supervision, a commander can reduce the need for explicit communication both up and down the chain of command and between units of the same echelon. There are tradeoffs in different organizations for communication, with organizations requiring less explicit communications having less operational flexibility.

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INCREASING COMMUNICATION SUPPLY BY IMPROVING TECHNOLOGY

Expected technological gains should yield incremental communications improvements for urban military operations. For now, current and emerging very-high-frequency (VHF) and ultra-high-frequency (UHF) radios are the best option for the dismounted infantryman. Most tactical military radios that are small and light enough to be carried by a soldier use VHF and UHF bands. The single-channel ground and airborne radio system, or SINCGARS, the baseline radio for U.S. forces, has evolved from a voice-only radio into one capable of secure voice, data, and network communications. The upcoming advanced system improvement program model has half the weight and size of the current SIP model used by the Army, and its battery life is double that of the first-generation SINCGARS.

The Army and the Marine Corps are experimenting with commercial-off-the-shelf radios to improve communications at the squad and fire team levels. Field experiments show that equipping every leader down to the fire team level can enhance situational awareness throughout a company. Adding intrasquad radios allows infantrymen to avoid "stacking" and bunching before entering buildings, leading to more general dispersion of forces and reduced fratricide, as well as greater coordination within and among squads, including between infantrymen and armored vehicles and tanks.

Cellular and satellite telephones are not suited for urban combat for many reasons, including poor security, low rates of data transmission, incompatibilities with existing military communication systems, and needs for fixed infrastructure that may be vulnerable during military operations. Nonetheless, these telephones may be useful in support and stability missions as well as in benign missions such as peacekeeping. The further one moves toward the rear of military operations, the more safely one can use commercial communication systems that may not be completely rugged or secure.

Unmanned aerial vehicle (UAV) relays can reduce link distance and overcome noise and line-of-sight communication problems for units in urban "canyons." Given that UAVs are still relatively complex machines and require skilled technicians and extensive ground support, this

option will probably not be practical for several years. Attritable relays carried by individual soldiers and positioned as tactical needs demand can also overcome breaks in line of sight between transmitters and receivers. Their short life span and easily compromised security probably limits their use to surgical missions such as seizing and controlling the interior of a single large building.

In the next three to ten years, further development of technologies such as UAV relays, software radios, ultra-wideband signaling, and array antennas may help overcome communication problems such as fading. Tactical UAVs smaller than those now in use could help improve combat communications; any tactical UAV capable of carrying more than 25 pounds might serve as a communications relay.

New software radios currently under development by the Defense Advanced Research Projects Agency use software applications to perform some of the functions performed by analog or hardware components in current radios. Software radios are capable of optimizing modulation, frequency, and power level to maximize performance in restrictive environments. Programmable software radios offer additional advantages over previous radio designs by allowing for improvements or enhancements without altering the radio hardware.

Ultra-wideband signals, which are spread across a larger band of frequencies than is required for normal narrowband transmission, offer promise as a signaling technique that is covert, jam resistant, and more resistant to fading. Array antennas can also reduce fading. Because such antennas must be large enough to capture wavelengths, building portable array antennas for UHF or VHF may not be practical, but portable array antennas may be possible for wireless communications using higher frequencies and shorter wavelengths.

Plans to field a "digitized" ground force will place a premium on reliable wireless communications. The limited doctrine on overcoming communication problems may raise new questions about how best to meet warfighter communication needs. But regardless of the technologies they carry, soldiers will always need to train with a basic set of tactics, techniques, and procedures that work in the absence of wireless communications.

RAND research briefs summarize research that has been more fully documented elsewhere. The research summarized in this brief was carried out in the RAND Arroyo Center; it is documented in Freeing Mercury's Wings: Improving Tactical Communications in Cities, by Sean J. A. Edwards, MR-1316-A, 2001, 84 pp., \$15.00, ISBN: 0-8330-3005-1, available from RAND Distribution Services (Telephone: toll free 877-584-8642; FAX: 310-451-6915; or Internet: order@rand.org). Abstracts of all RAND documents may be viewed on the World Wide Web (<http://www.rand.org>). Arroyo Center URL: <http://www.rand.org/organization/ard/>. Publications are distributed to the trade by NBN. RAND® is a registered trademark. RAND is a nonprofit institution that helps improve policy and decisionmaking through research and analysis; its publications do not necessarily reflect the opinions or policies of its research sponsors.

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