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SHARED AWARENESS IN URBAN OPERATIONS

By

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A paper submitted to the faculty of the Naval War College in partial satisfaction of the requirements of the Department of Joint Military Operations.

The contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College or the Department of the Navy.

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17 May 2005

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Abstract

The confluence of increasing future urbanization of world population, along with the DoD's vision of full spectrum dominance, enabled by the network-centric concept of shared situational awareness, drives the question of what benefits the military can expect from shared situational awareness when attacking an enemy in a city. Research demonstrates that shared situational awareness will open new alternatives for the operational commander, improving the probability of defeating an enemy in a city. These new alternatives stem from the faster operating tempo and improved synchronization provided by shared awareness. But achieving the level of shared awareness to obtain these advantages requires overcoming several obstacles. Sensors and communications networks must be improved to overcome the challenges of the urban environment. Additionally, the military must become more effective at fusing data from a variety of sensors into useable information that aids the warfighter in completing the mission. Finally, the military should develop doctrine and training to ensure personnel understand how best to achieve shared awareness.

Introduction

Sun Tzu wrote that “The worst policy is to attack cities. Attack cities only when there is no alternative.”¹ Attacking a city is one of the most challenging of all military actions, yet a myriad of situational factors may require commanders to attack belligerents in urban terrain to meet their mission objectives. The commander’s objective may be to secure a city captured by the enemy, such as the Russian attacks on Grozny. Or, the commander may seek to defeat enemy forces that sought sanctuary in a city to escape the technological dominance of U.S. forces in open combat, such as when Iraqi forces shed their uniforms to blend in with non-combatants in Baghdad during Operation IRAQI FREEDOM (OIF).

Americans have executed offensive combat operations in cities in every major war in the latter half of the twentieth century. Examples include Brest in World War Two, Seoul in the Korean War, Hue in Vietnam, Kuwait City in the First Gulf War, and Baghdad in the Second Gulf War.² Furthermore, the National Intelligence Council (NIC) wrote that increasing global urbanization is one of the key trends that describes the future. By 2015, the NIC expects more than half of the world’s population to live in urban environments, and the number of cities with more than 10,000,000 inhabitants will double.³ The trend of increasing urbanization, combined with the frequency of urban combat in previous U.S. wars, makes it reasonable to assume that America will engage in urban combat in the future.

In parallel with the trend towards increasing urbanization, the DoD is pursuing a vision of full spectrum dominance. The concept of Network-Centric Warfare (NCW) describes how information superiority produces enhanced combat power and enables full spectrum dominance.⁴ A key component of NCW is development of a common relevant operational picture (CROP) to build shared situational awareness between commanders.

Various authors define shared situational awareness differently. For purposes of this paper, shared situational awareness is a common understanding between commanders of relevant information about friendly and enemy forces. Shared situational awareness serves as a basis for many of the proposed NCW benefits, such as increased operational tempo, increased speed of command, and improved battlespace synchronization.⁵

Urban combat presents one of the most challenging environments in which to build shared situational awareness. The thesis of this paper is that shared awareness can improve the probability of success when attacking an enemy in a city; however, significant challenges in the areas of information transport and intelligence, surveillance and reconnaissance (ISR) for urban areas must be overcome to maximize those benefits.

The Urban Environment

Complexity and dynamic change distinguish military operations in urban terrain. From this complexity, a triad of distinctive characteristics emerges: physical terrain, infrastructure, and the population.⁶

Physical terrain serves as the foundation upon which infrastructure is built and the population moves. Its complexity stems from the myriad of structures in a city. It consists of surface and subterranean areas, interior and exterior spaces, in addition to airspace.⁷ These multidimensional spaces and areas combine in a vast number of ways, making each urban situation unique, presenting its own opportunities and challenges to the commander.

Urban infrastructure includes the physical infrastructure and services infrastructure of the city. Examples of the physical infrastructure include the transportation network, hospital buildings or power plants. Examples of the service infrastructure include food and water distribution, power and communications services.⁸ Infrastructure may be an asset or limiting

factor for a commander. The commander may be able to use urban infrastructure to support his concept of operations. At the same time, the commander may need to preserve urban infrastructure to support the inhabitants during and after combat operations.

A unique feature of the population in urban combat is the density of non-combatants when compared to non-urban environments.⁹ Another important feature can be the difficulty in distinguishing combatants from non-combatants when enemy soldiers attempt to blend in to avoid targeting by U.S. forces.

Combat operations interact with the urban characteristics to increase the dynamics of the urban environment. Physical terrain changes as fires destroy buildings and create rubble. Infrastructure changes as transportation networks adapt to damaged roads. Non-combatants stream away from perceived combat areas, or become trapped by the swirl of combat.

Why Engage in Urban Operations?

Major General Robert Scales, retired past commandant of the Army War College, theorized that an enemy force may choose to occupy a city to reduce U.S. technical advantages and put the factor of time on their side.¹⁰ Time can shift to favor the enemy in two ways when he occupies a city. If a coalition commander does not immediately attack the city, the enemy gains time to implement diplomatic or information activities to break-up the coalition or reduce the desire to engage in combat operations. If the commander attacks into the city, then the enemy can also maintain the advantage of time by drawing American forces into a protracted, bloody struggle. This has a two-fold effect. First, the use of complex urban terrain can preserve enemy combatant forces by somewhat shielding them from U.S. precision weaponry. Second, by protracting the conflict and causing disproportional American casualties, the enemy can reduce American will to win because of perceived

aversion to large casualties and distain for protracted operations. In return for these potential advantages, the enemy forfeits initiative and freedom of operational maneuver because he is fixed in the city.

Concepts for Defeating an Enemy in a City

General Scales described two alternatives at the operational level to defeat an enemy who occupies a city: attack the city or establish a cordon around the city, letting the city collapse on itself.¹¹ These two alternatives vary in how they manipulate the factor of time. The general surmised that if the enemy draws American forces into a protracted bloody struggle in a city, then time is on the side of the enemy, because the enemy can, through time and attrition, inflict large casualties on American forces and reduce our national will to fight. Alternatively, friendly forces may be able to isolate the city, turning time against the enemy, as the city runs out of food and water, eventually causing the city and the occupying enemy forces to collapse.¹²

General Scales' cordon option is appealing from the standpoint of controlling the factor of time and reducing U.S. casualties. This option leverages American strengths in precision firepower and sensor technology to defeat the enemy at minimum cost. The general proposes using both terrestrial and airborne sensors to provide surveillance of possible infiltration routes through the cordon, minimizing the manpower needed to enforce the cordon.¹³ Surveillance systems would help pinpoint key targets in the city, allowing commanders to direct precision fires at those key targets at the appropriate time to speed the collapse of the enemy in the city. Precision fires reduce the need for close combat in the city and therefore reduce the potential for American casualties. Precision fires also diminish reliance on massed firepower, as used by the Russians in January 1995, when they destroyed

large sections of Grozny with massed artillery.¹⁴ Surveillance-based precision fires reduce potential negative international opinion that comes from killing large numbers of non-combatants when a commander uses massed fires against a city.

However appealing the cordon option may appear, it may also be impractical at times. Political issues, combined with the large number of non-combatants in the city, may restrict options available to the commander. At the operational level, these factors may reduce palatability of a cordon, as exemplified by the April 2004 cordon around Fallujah. The Fallujah cordon isolated the battlespace and reduced the capability of enemy forces in the city, but also increased political turmoil in the new Iraqi Governing Council since the cordon restricted food and medicine for non-combatants.¹⁵ Additionally, the cordon served to unite previously separate insurgent factions who provided food for those inside the cordon and joined in attacks against Americans.¹⁶ This example demonstrates how external forces may combine to push time onto the side of the enemy. These factors may drive the operational commander to attack enemy forces in a city to once again put time on the side of an American-led coalition. But if the commander chooses to attack into the city, he risks meeting enemy combatants on their own terms. Attack into a city could allow the enemy to spill the blood of a large number of American soldiers, reducing U.S. national will to pay the price necessary to bring the conflict to a successful termination, favorable to U.S. objectives.

Shared situational awareness, however, may allow the commander to attack the city without allowing the enemy to dictate terms of the engagement. NCW proponents believe the proper employment of information technology can generate increased combat power, providing for increased operating tempo, improved synchronization, enlarged engagement envelopes, and reduced enemy sanctuaries. If these concepts apply to an attack against an

enemy in a city, then the enemy may not be able to execute his plan of prolonged attrition warfare against American forces in the city to reduce U.S. national will.

Network-centric literature describes shared awareness as the basis for many of these operational enhancements. Shared awareness between commanders and staffs could increase speed of planning, contributing to faster operating tempo. It could also enhance a force's ability to synchronize effects in time and space to achieve a desired effect on the enemy. Part of the foundation of increased synchronization is the ability of sensor networks to provide engagement quality coordinates to units with precision fire capability. The synchronization of precision fires with schemes of maneuver takes advantage of the reciprocal nature of fires and maneuver. Fires create opportunities for maneuver. Maneuver drives the enemy to react, creating opportunities for precision fires. Together, these effects may enable increased operating tempo, decreased enemy ability to react, and increased probability of success against an enemy in a city. Sensor networks also enlarge engagement envelopes, since any number of sensors throughout the battlespace can cue the engaging weapon, and weapons are no longer tied to a single sensor.

In a similar manner, shared awareness supports General Scales' cordon alternative. Airborne and ground-based sensors can improve isolation of the battlespace by surveying possible infiltration routes, providing commanders with information that would allow them to move forces to stop infiltration or engage infiltrators with precision fires. Sensors could also provide information to commanders on the status of some targets in the city, allowing the commander to direct precision fires to engage those targets.

Thus, the concept of shared awareness underpins both the cordon alternative and the NCW enhanced attack alternative to defeating an enemy in a city. The difference is the degree to which shared awareness must be implemented to support each concept.

Degrees of Situational Awareness

Just as there are degrees of net-centricity, there are degrees of situational awareness. One could have no situational awareness, local situational awareness, beyond line-of-sight awareness, basic shared awareness, or advanced shared awareness.¹⁷ Differences in situational awareness can exist at the operational and tactical levels of war. Local awareness can be achieved by using one's own senses. Beyond line-of-sight awareness comes from another person or sensor transmitting information about an area that is beyond one's ability to sense. Shared awareness involves two-way communication among multiple battlespace entities, sharing information from their respective local areas with others and allowing each to achieve a greater overall understanding of the battlespace.

Commanders require different minimum levels of situational awareness to execute successfully different courses of action when defeating an enemy in a city. Isolation of a city via a cordon requires local situational awareness if the commander is able to ring the city. If unable to ring the city, the commander requires beyond line-of-sight awareness to detect and halt infiltration. Thus, one effect of beyond line-of-sight awareness is that a commander may need fewer forces to isolate a city.

If the commander chooses to attack into the city, he will require different levels of situational awareness depending on the scheme of maneuver selected. There are five forms of maneuver: frontal attack, penetration, turning movements, envelopment, and infiltration.¹⁸ Frontal attack requires only local situational awareness; however, knowledge of enemy

disposition and specific objectives provided by beyond-line-of-sight awareness may improve the odds of success. Penetration requires slightly more situational awareness than frontal attack, since successful penetration depends on the commander's knowledge of enemy positions. Turning movements and envelopments generally involve maneuver outside of a city to approach an exposed flank. These maneuver forms are challenging when attacking an enemy in a city, since urban complexity makes it difficult to find an exposed flank to attack. Both turning movements and envelopments require beyond-line-of-sight awareness of enemy dispositions to understand the best place to strike the enemy. Infiltration requires a great deal of situational awareness, and one could argue that it requires a degree of *shared* awareness for success.¹⁹ Infiltration necessitates shared awareness because infiltrating units rely upon knowledge of friendly and enemy locations to determine which friendly units need mutual support and which enemy forces should be attacked, bypassed, or isolated.

From this taxonomy of maneuvers and awareness requirements, one can surmise that increased levels of situational awareness open new maneuver choices for the operational commander facing urban combat. In a similar manner, one could argue that increased levels of situational awareness could increase the probability of success of a chosen maneuver scheme that does not normally require advanced shared awareness. Probability of success increases because increased levels of situational awareness improve commanders' battlespace understanding. Battlespace understanding enables greater ability to attack, bypass, or isolate enemy forces, as required to attain mission objectives. Additionally, better awareness takes advantage of the reciprocal nature of fires and maneuver, allowing indirect fires to more accurately support maneuver efforts and allowing maneuver to push the enemy into situations where he is more vulnerable to precise fires.

As an example, during the first battle of Grozny in 1994, Russian forces executed a penetration attack versus Chechen defenders.²⁰ The penetration was unsuccessful, resulting in the virtual annihilation of the Russian 131st Motorized Brigade.²¹ One fundamental reason for the failure was limited situational awareness at the operational and tactical levels prior to the attack. Had Russian commanders attained greater situational awareness, they might have chosen a different scheme of maneuver or at least have been able to support the penetration when it ran into trouble.

When contrasting the first battle of Grozny with the American penetration into Baghdad in 2003, one can see that in the latter example, operational commanders had beyond-line-of-sight awareness provided by unmanned aerial vehicles orbiting above penetrating forces. Additionally, a system called Force XXI Battle Command, Brigade and Battalion (FBCB2) provided limited shared awareness at the tactical and operational levels, passing information about vehicle locations to units participating in the penetration, as well as to the Fifth Corps headquarters.²² This allowed tactical and operational commanders to track progress of the penetration and provide direct support if it had been needed.

Advanced Shared Awareness

There are, as of yet, no examples of advanced shared awareness in actual urban combat operations, since the systems are not yet fully fielded. But one can look at various writings to piece together an idea of the possibilities of an advanced degree of shared awareness. A CROP could enable advanced shared awareness in an urban environment by displaying blue force and red force locations, terrain, weather, and other relevant information.²³ Terrain maps would include three-dimensional information about the complex urban environment and be updated as urban terrain changes due to combat operations. Fused

information from an array of airborne and ground-based sensors, along with digitized human intelligence (HUMINT) reports, would feed the CROP. Sensors would provide target-quality information, allowing commanders to engage with indirect precision fires as needed. Fused information would be distributed to different echelons to enable appropriate and rapid combat operations. Such a system would provide collaborative tools to speed planning.²⁴ Commanders up and down the chain would have sufficient awareness of blue and red force locations to improve synchronization of attacks. Tight synchronization with close air support would be provided by integrating the ground CROP with aircraft situation displays. The integration of ground and air would allow ground commanders to designate and prioritize targets through their common operational display, then transmit target quality coordinates to the platform providing precision fires. Speedier planning, target quality coordinates, and tight synchronization would enable blue forces to combine fires and maneuver to engage red forces rapidly and decisively before the enemy could react to the blue force attack. At the operational level, this could open up new schemes of maneuver, unavailable before, and would serve to deny sanctuary to the enemy across the depth of the battlespace.

Requirements and Challenges

The above listed benefits make advanced shared awareness a desirable force multiplier. But there are a number of requirements necessary to achieve advanced shared awareness. Shared awareness requires a system to create a CROP. The system requires sensors to provide data. Users require a fusion capability to transform sensor data into relevant information. The system also requires a reliable communications network to interconnect sensors, fusion nodes, and users.²⁵

The goal of advanced shared awareness will remain elusive unless the DoD tackles a number of challenges presented by the urban environment. Tall buildings, interior spaces, and other complex terrain can restrict sensor observations. These same features limit information velocity by severing communications links or restricting available bandwidth.²⁶ Additionally, the number of sensors and the dynamic nature of the urban environment challenges the ability to synthesize data into information.

Recommendations and Conclusion

The military is currently developing and fielding a variety of sensors to operate in different urban environments. Persistent overhead sensors, carried by unmanned aerial vehicles, constrain an enemy's ability to move openly outdoors.²⁷ Interior spaces present greater challenges to sensors than exterior spaces. A single sensor inside a building or tunnel will, most likely, be unable to attain coverage of all the rooms of that interior space. To overcome coverage restrictions in interior spaces, the military should pursue sensors that can be easily deployed to cover multiple spaces throughout a building. Micro-sensors hold promise in overcoming the limitations of interior spaces, since their size may allow deployment of many sensors at once to detect people in different interior spaces and relay information outside of a building.²⁸

But sensors, in the foreseeable future, will be unable to determine the intent of a person, and therefore be unable to reduce the fog created by combatants hiding among non-combatants. In an environment where combatants will attempt to hide among non-combatants to avoid targeting, determining intent could be vital. The best way to determine intent, or understand the mood of a population in a certain sub-region, is through HUMINT.

Thus, HUMINT will always be an essential part of surveillance and reconnaissance in the urban environment to overcome the limitations of sensors.

Improved training of ground personnel can increase the quantity and quality of reported HUMINT information. Each interaction between a soldier on patrol and the local civilian population can potentially provide information about the local mood, threat locations, or the location of combatants.²⁹ But this understanding can only be shared if reported. Of the approximately 400,000 patrols conducted in Iraq from March 2003 to April 2005, only about 6,000 intelligence reports reached brigade level.³⁰ Training programs can enhance the quantity and quality of HUMINT reports by teaching ground personnel what to look for, and how the military uses the information.³¹

HUMINT reporting is important, but to improve overall shared awareness, one must also improve the velocity of information reporting and the degree to which it is shared. Information velocity increases when HUMINT reports no longer have to wait for a patrol to return to base to be transcribed and analyzed. Velocity is imperative to deal with rapidly changing combat situations, as exemplified in the battle of Grozny, where widely distributed Chechen assault teams quickly massed to attack Russian patrols, then dispersed again to avoid counter-attack.³² Velocity will increase when land forces can effectively digitize HUMINT when it is collected, and transmit that information for analysis and distribution via a communications link. In October 2004, Collin Agee, the Director of ISR Integration in the Army's Office of the Deputy Chief of Staff for Intelligence admitted that the Army is "not well postured to digitize human intelligence."³³ To increase velocity and sharing of HUMINT, the DoD should implement programs to digitize HUMINT, and provide soldiers with equipment to transmit HUMINT reports when they are collected.

Creating fused information from data provided by sensors and HUMINT reports increases the quality of information available through the CROP, and therefore increases the probability of achieving an advanced level of shared awareness. Explicit data, such as unit location and terrain, can be rapidly fused and displayed on a CROP because does not require much interpretation. Fusion of ambiguous data is more challenging, and requires analysts to synthesize the data into information. HUMINT will often be ambiguous in nature.³⁴ It may require analysts to comprehend trends or understand data in the context of the local culture. Because urban operations rely on a combination of sensors and HUMINT, one can infer that there will be a continued need for analysts to work to fuse ambiguous data into coherent information for a CROP. One can also infer that there may be a greater need for analysts to fuse data during urban operations because of the greater population density that might provide HUMINT than in a non-urban setting.³⁵ To facilitate fusion of ambiguous data in the urban environment, the DoD should experiment and then develop doctrine regarding how commanders should incorporate larger HUMINT quantities in their exploitation and data fusion process.³⁶

Line-of-sight communications links often fail in urban settings because buildings impede signals. For example, the Mounted Digital Automated Communications Terminal, a situational awareness system used in OIF, was only of marginal use because it relied on line-of-sight communications that routinely failed.³⁷ Satellite links are a partial solution because they reflect data off satellites in space instead of attempting to transmit through urban structures. But mobile satellite communications do not provide sufficient bandwidth for sensors in the field. Satellite links are also ineffective indoors. Communications network challenges can be mitigated through fielding communications relays to send signals over or

around buildings. DARPA is developing communications relays that mitigate the urban line-of-sight problem.³⁸ The technology will relay communications around urban terrain and automatically reconfigure communications to maximize information throughput, while minimizing the ability of a sophisticated enemy to disrupt transmissions.

All of the technology advances to support shared awareness will be of little use without appropriate doctrine and training. The military currently has little doctrine about using the capabilities inherent in network-enhanced warfare. *Doctrine for Joint Urban Operations* notes that a CROP helps minimize fratricide, but does not indicate how advanced shared awareness, supported by a CROP, can aid in defeating an opponent.³⁹ Doctrine mentions the need for superior situational awareness for infiltration, but does not specify how various levels of awareness enable alternate forms of maneuver. Doctrine notes the importance of HUMINT, but does not indicate how to surge HUMINT processing and analysis to provide rapid information in an urban environment. Experiments and experience should lead to new doctrine that provides guidance in these areas.

Training is vital to ensure military personnel can operate systems effectively. Commanders must understand system capabilities and limitations. In OIF, commanders grew confident of the FBCB2 system's ability to display blue-force locations on a map.⁴⁰ But commanders also had to learn the system's limitations. Information velocity was relatively slow, with the position of vehicles being updated across the net approximately every four or five minutes.⁴¹ The relatively slow information velocity reduced the system's ability to track rapidly maneuvering forces. In this example, low information velocity forces a commander to rely on information from other sources to direct fires, since the system could not deliver engagement quality coordinates for maneuvering targets. This specific limitation

may change in the future, but demonstrates why commanders must understand the limitations of shared awareness systems. Failure to understand system capabilities and limitations may lead commanders to either expect more from the system than it can deliver, or fail to exploit system capabilities to the maximum advantage on the battlefield.

In conclusion, improving shared awareness can open new alternatives for the operational commander and increase the probability of defeating an enemy in a city. Improved sensors could deny the enemy sanctuary in interior spaces. Increased battlespace awareness, faster operating tempo, and improved synchronization may allow American forces to attack the enemy on their own terms, rather than devolving to prolonged attrition warfare in the city. But achieving the level of shared awareness to obtain these advantages requires overcoming several obstacles. Micro-sensors should be pursued to overcome the tyranny of interior spaces. The DoD should train ground personnel to enhance the quantity and quality of HUMINT reporting. Concomitantly, the military must become more effective at fusing data into useable information. Communication relays should be developed to ensure data and information can be rapidly passed through the network to fusion centers or military personnel in the field. Independent of technological advances, the military should write doctrine to explain how network-enhanced systems can help commanders attain mission objectives. Additionally, the military needs to ensure personnel receive training to understand system capabilities and limitations. The challenges are great, but the effort to achieve advanced shared awareness in the urban environment will better prepare the military for conflict in the twenty-first century.

NOTES

¹ Samuel B. Griffith, ed., *Sun Tzu, The Art of War* (New York: Oxford University Press, 1963), 78.

² Headquarters Department of the Army, *Field Manual 3-06.11: Combined Arms Operations in Urban Terrain* (Washington D.C., February 2002)
<http://www.army.mil/usapa/doctrine/90_Series_Collection_1.html> [21 March 2005]1-8.

³ U.S. National Intelligence Council, *Global Trends 2015: A Dialogue About the Future With Nongovernment Experts* (Washington D.C.: GPO, 2000)
<<http://www.cia.gov/cia/reports/globaltrends2015/#link3>> [15 April 2005].

⁴ David S. Alberts, John J. Garstka, and Frederick P. Stein, *Network Centric Warfare*, 2d ed (Washington D.C.: DoD C4ISR Cooperative Research Program, 1999), 54-56.

⁵ Ibid., 91.

⁶ U.S. Department of Defense, *Joint Publication 3-06: Doctrine for Joint Urban Operations* (Washington D.C., September 2002)
<http://www.globalsecurity.org/military/library/policy/dod/doctrine/jp3_06.pdf> [18 March 2005], I-2.

⁷ Ibid., I-4.

⁸ Ibid., I-5 - I-6.

⁹ Ibid., I-4.

¹⁰ Robert H. Scales, Jr., *Future Warfare Anthology* (Carlisle Barracks, PA: U.S. Army War College, 2000), 210-211.

¹¹ Ibid., 213-216.

¹² Major General (Retired) Robert H. Scales also describes the potential impact of a cordon on the perceptions of the urban population about those occupying the city. He states that “the underlying purpose is to shape the perception that the enemy is a hostile occupying force.” Source: Ibid., 215.

¹³ Ibid., 214.

¹⁴ Timothy L. Thomas describes intense artillery barrages against Grozny on 7 January 1995, where roughly 15-20 shells were landing in the city per minute. The 7 January barrages provided support for Russian soldiers fighting in the city. He also describes the Russians raining artillery shells on the center of Grozny on 12 January 1995, with approximately six shells landing per minute for three hours. The artillery barrage on 12 January was augmented by 40 rockets, which also hit the city center. The Russians used the artillery barrage to prevent Chechen resupply and facilitate recapture of the city.

Source: Timothy L. Thomas, "The Caucasus Conflict and Russian Security: The Russian Armed Forces Confront Chechnya III. The Battle for Grozny, 1-26 January 1995," *Journal of Slavic Military Studies* 10, no. 1 (March 1997) : 69, 75.

¹⁵ Details of the encirclement are described by Robert D. Kaplan, an embedded reporter with the 1st Battalion of the 5th Marine Regiment, which participated in the cordon and later in the attack on Fallujah. The 2d Battalion of the 1st Marine Regiment was positioned on the northern side of the city. The 1st Battalion of the 5th Marine Regiment was positioned on the south and east sides of the city. The Euphrates river bounded the western edge of the city, completing the cordon. Source: Robert D. Kaplan, "Five Days in Fallujah," *Atlantic* 294, no. 1 (July-August 2004) : 126.

The political turmoil caused by the cordon of Fallujah is described by John F. Burns. Two members of the Iraqi Governing Council resigned. Many others protested because American actions in Fallujah were, in their opinion, unjustly punishing citizens of the city. Source: John F. Burns, "Fighting Halts Briefly in Falluja; U.S. Convoy Hit Near Baghdad," *New York Times*, 10 April 2004 : A1.

¹⁶ Jeffrey Gettleman describes how the cordon around Fallujah served as a common rally point for previously rival religious sects in Iraq. Families in Baghdad donated food. Both Shiite and Sunni men attempted to deliver the food to Fallujah. Members of both religions swarmed towards Fallujah to fight against the Americans. Source: Jeffrey Gettleman, "Ex-Rivals Uniting," *New York Times*, 9 April 2004 : A1.

¹⁷ According to David S. Alberts and Richard E. Hayes, there are five levels of network-centric capability. Level zero uses organic resources to obtain information, and has limited sharing of information between organizations. Level one increases information sharing between organizations. Level two introduces collaboration between battlespace entities. Level three requires interoperability in the cognitive domain to achieve shared awareness. Level four achieves dynamic self-synchronization through interoperability in the social domain. Source: David S. Alberts and Richard E. Hayes, *Power to the Edge* (Washington D.C.: DoD C4ISR Cooperative Research Program, 2003), 109 - 110.

¹⁸ Headquarters Department of the Army, *Field Manual 3-06: Urban Operations* (Washington D.C., June 2003)

<http://www.army.mil/usapa/doctrine/90_Series_Collection_1.html>
[21 March 2005], III-16.

¹⁹ *Joint Publication 3-06: Doctrine for Joint Urban Operations*, III-17, states that “Infiltration depends on superior situational awareness and understanding of the urban area, careful selection of objectives, detailed planning, and efficient support and deception.” Infiltration is the only form of maneuver that is described in *Doctrine for Joint Urban Operations* as requiring superior situational awareness. Descriptions of other forms of maneuver do not identify situational awareness requirements.

²⁰ *Ibid.*, III-16.

²¹ Timothy L. Thomas notes how the Russian’s found it difficult to locate Chechen defensive positions and strong points. This lack of awareness as to the Chechen defense greatly contributed to the demise of the 131st Motorized Brigade. Source: Timothy L. Thomas, “The Battle of Grozny: Deadly Classroom for Urban Combat,” *Parameters* 29, no. 2 (Summer 1999) : 95.

²² Force XXI Battle Command, Brigade and Battalion (FBCB2) had an extension module called Blue Force Tracker; therefore, some of the literature calls the entire system Blue Force Tracker (BFT).

Information about Fifth Corps headquarters was obtained from an interview with the Fifth Corps commander, Lt Gen William Scott Wallace. Source:
“Interview: Lt Gen William Scott Wallace” *Frontline*, 26 February 2004
<<http://www.pbs.org/wgbh/pages/frontline/shows/invasion/interviews/wallace.html>>
[15 April 2005].

²³ The DoD Office of Force Transformation noted that the United Kingdom’s Joint Operational Picture model contains eight layers of information: logistics, nuclear-biological and chemical (NBC), fires coordination, neutrals, friendly units, enemy units, weather, and geospatial. The Force XXI Battle Command Brigade and Battalion (FBCB2) system used by American and British ground forces in OIF provided friendly unit information, geospatial information, and limited enemy unit information.
Source: David Mawby, Ian McDougall and Greg Boehmer, *A Network-Centric Operations Case Study: US/UK Coalition Combat Operations During Operation Iraqi Freedom* (Washington D.C.: U.S. Department of Defense, March 2005)
<http://www.insidedefense.com/secure/data_extra/pdf4/dplus2005_0923.pdf>
[29 April 2005], 3-9, 5-2.

²⁴ Rick Lynch, *Lessons Learned: Commanding a Digital Brigade Combat Team* (Alexandria, VA: Institute for Defense Analyses, June 2001)
<<http://bctc.hood.army.mil/references.aspx?r=27&s=1>> [12 April 2005], 20.

²⁵ Alberts and Hayes, *Power to the Edge*, xv.

²⁶ Alberts, Garstka and Stein describe information velocity as a function of data latency (*Network Centric Warfare*, 139). Data latency is a function of both data throughput and speed at which data can be processed. Assuming processing speed is fixed once a system is fielded, data throughput for a communications link becomes the primary driver of data latency and information velocity. Complex terrain reduces data throughput by attenuating a radiofrequency signal through absorption or fading. For example, the walls of a building attenuate the strength of a radiofrequency signal by absorbing some of the signal strength.

²⁷ Major General (Retired) Robert H. Scales notes that an enemy with intimate knowledge of a city has a two-dimensional information advantage. Overhead sensors allow American forces to achieve a three-dimensional information advantage outside of buildings. This information advantage in the third dimension decreases enemy ability to move and mass outside of urban structures.

Source: Robert H. Scales, "Urban Warfare: A Soldier's View," *Military Review* 85, no. 1 (January - February 2005) : 12.

²⁸ Maryann Lawlor describes the concept of "microbots" that weigh less than one ounce and could transport sensors to appropriate areas in the battlespace.

Source: Maryann Lawlor, "Robotics Concepts Take Shape," *Signal* 58, no. 3 (November 2003) : 16-20.

DARPA funded the University of California at Berkeley to develop Smart Dust. The project was completed in 2001. The project goal was to develop a massively distributed sensor network, where sensor nodes would be small and autonomous. The project demonstrated an autonomous sensor node and an autonomous communications node, each of which was less than 130 cubic millimeters. Nodes the size of a cubic inch, based on technology from this project, are now commercially available.

Source: Clark T.C. Nguyen, "Smart Dust," *MEMS Project Info*, n. d.

<http://www.darpa.mil/mto/mems/summaries/projects/University_44.html>
[27 April 2005].

²⁹ The term "ground personnel" is used in the previous sentence to emphasize how different categories of military personnel may be able to provide HUMINT information. The example of soldiers on patrol comes from Robert K. Ackerman, "Army Teaches Soldiers New Intelligence-Gathering Role," *Signal* 59, no. 8 (April 2005) : 38.

Glenn, Hartman and Gerwehr suggest the military also consider combat service support personnel as a source of HUMINT since they have frequent contact with noncombatants. One could also expand this concept, to train personnel from other services to collect HUMINT if they have frequent contact with noncombatants.

Source: Russell W. Glenn, Steven L. Hartman and Scott Gerwehr, *Urban Combat Service Support Operations* (Santa Monica CA: RAND, 2003), 14-15.

³⁰ Ackerman, "Army Teaches Soldiers New Intelligence-Gathering Role," 38.

³¹ Ibid., 37.

³² Robert K. Ackerman, "Training, Not Technology, Is Key to Urban Warfare," *Signal* 55, no. 9 (May 2001) <<http://www.afcea.org/signal/articles/anmviewer.asp?a=544>> [9 April 2005].

³³ Frank Tiboni, "Soldiers as Sensors," *Federal Computer Week* (1 October 2004) <<http://www.fcw.com/fcw/articles/2004/0927/web-sense-10-01-04.asp>> [9 April 2005].

³⁴ HUMINT may be either ambiguous or explicit. An example of explicit HUMINT is an informer telling a soldier that improvised explosive devices have been hidden at a specific road intersection. This explicit information could be easily placed on a common operational picture. An example of ambiguous HUMINT is an informer describing that a group of insurgents is considering attacking one of three targets. An analyst with additional information might be able to determine the likely target.

³⁵ Russell W. Glenn and Gina Kingston, *Urban Battle Command in the 21st Century* (Santa Monica, CA: RAND, 2005) <<http://www.rand.org/publications/MG/MG181/>> [26 April 2005], 86.

³⁶ Glenn, Medby, Gerwehr, Gellert and O'Donnell provide a doctrinal perspective of the need to be able to surge HUMINT analysis capabilities.

Source: Russell W. Glenn, Jamison Jo Medby, Scott Gerwehr, Fred Gellert and Andrew O'Donnell, *Honing the Keys to the City* (Santa Monica CA: RAND, 2003), 14.

Major Bill Benson and Captain Sean Nowlan provide a tactical perspective that echoes the doctrinal perspective above. In their experience, there is a need for the ability to surge HUMINT capability at the battalion level.

Source: Bill Benson and Sean Nowlan, "Tactical Intelligence Shortcomings in Iraq," *Armor* 114, no. 2 (March-April 2005) : 21.

³⁷ The Marine Corps Systems Command Liaison Team reported that the Mounted Digital Automated Communications Terminal (MDACTS) “was ignored” for a number of reasons. Communications speeds were slow, the user interface was difficult to use, and line-of-sight communications tended to fail.

Source: Marine Corps Systems Command Liaison Team, *Field Report, Central Iraq* (April 20 - 25, 2003) <http://www.globalsecurity.org/military/library/report/2003/oif_mcsc-field-report_apr2003.doc> [26 April 2005], 1-2, 13.

³⁸ Timothy Gibson, “Needed: Self-Configuring Networks,” Interview by Joab Jackson, *Government Computer News* 23, no. 33 (22 November 2004) : 18.

³⁹ *Joint Publication 3-06: Doctrine for Joint Urban Operations*, III-3.

⁴⁰ Lt Col John W. Charlton wrote that he only received a minimum amount of training on the Force XXI Battle Command Brigade and Battalion (FBCB2) system prior to OIF. The short amount of training did not allow him to become confident in the system’s abilities prior to combat. He grew confident in the system’s capability over time, as subordinates showed him different features, and as he watched the system during combat operations.

Source: John W. Charlton, “Baptism by Fire: One Lieutenant Colonel’s Conversion to Digital Battle Command,” *Infantry* 92, no. 1 (Fall 2003) : 30-31.

⁴¹ Anthony H. Cordesman, *The Intelligence Lessons of the Iraq War(s)* [Second Rough Working Draft] (Washington D.C.: Center for Strategic and International Studies, 6 August 2004) <http://www.csis.org/features/iraq_intelligenceiraqiwar.pdf> [9 May 2005], 39.

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