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Network-Centric Special Operations-- Exploring New Operational Paradigms

Captain Greg Gagnon, USAF

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Introduction

Network-centric operations are achieved by networking the force to create shared situational awareness derived from common operating information that is relevant, timely, and accurate. Network-centric warfare (NCW) results from using this shared situational awareness to self-synchronize operations, speed decision making, and increase the speed of operations. In this paper I explore the utility of network-centric warfare for special operations. The paper begins with a description of a hypothetical future network-centric special operation, following which, a review of the network-centric warfare is provided. Next, the paper summarizes an academic theory of special operations drawn from a book by Capt William McRaven. The fourth section of the paper presents the results of cross-pollinating network-centric warfare and McRaven's principles of special operations -- what I've termed network-centric special operations. Today, within US Special Operations Command, there are a number of initiatives which represent a drive toward network-centric special operations. This paper helps to conceptualize the academic theory that initiatives such as the Naval Special Warfare Command's Mission Support Center[1] and Special Warfare Automated Mission Planning System (SWAMPS)[2] are seeking to achieve.

Although new technologies and reach-back communications are currently being integrated into special operations, very little academic time has been spent reflecting on the operational impacts for special operations doctrine and strategy. This paper is a beginning to that debate.

A hypothetical future scenario of a network-centric special operation

A network-centric special operations entity, called an A-team,[3] is assigned a direct action mission to destroy a deep underground communications facility's ability to receive and transmit electronic information. The A-team leaves its stateside base and steps into their mission planning transport, which is an aerial vehicle connected to the joint force information grid. As the team moves into theater they communicate electronically with their assigned information gathering team, known as the I-team, which resides at the Special Operations Force (SOF) mission support center. The SOF mission support center maintains a staff of expert SOF planners and information gatherers. The I-team, already aware of the A-team's mission, pushes planning information to the en-route A-team for further detailed analysis and planning. The I-team stays in contact with the A-team throughout the mission. The I-team is responsible for the A-team's information

management before, during, and after the mission. During the planning process the A-team identifies their mission "information profile." This information profile identifies the information the A-team will need during the operation while they maintain their communication links in receive mode, in order to minimize their signature. As the A-team builds its plan, the team collaborates with experts who the I-team have brought on-line to provide needed target specific and culturally specific information. During the collaborative planning process a new innovative approach is identified. The A-team leader chooses the new innovative approach and continues his planning. Since this operation is on a short timeline, much like most operations these days, the A-team didn't have the opportunity to do a "physical" full-dress rehearsal. Instead the A-team commander directs the I-team to run the mission analysis simulation. The simulation identifies one critical area of vulnerability for the A-team commander to reconsider. As the A-team builds its plan, the team incorporates the standard rules of engagement and rule set, which is techniques, tactics, and procedures that they have practiced day-in and day-out.

As the A-team enters the theater the team transfers to tactical transport and reports to the supported commander. She informs the A-team that its mission is in support of other conventional strikes designed to isolate the enemy leadership. As the A-team ingresses to target, they receive an abort call from the supported commander. The team's target has been neutralized by a conventional force strike on the electrical grid, but more importantly, time sensitive intelligence has located the enemy's military commander. The A-team's new task is to snatch the commander.

Throughout the mission the I-team continues to monitor the network. Aware of the new mission tasking the I-team gathers the A-team's new information needs. As the A-team receives orders from the supported commander the A-team also receives support information from the I-team.

The A-team moves to their new location by using conventional lift that the A-team identified using their common operating picture they share with the conventional forces. With the building schematics transferred from the I-team, the A-team collaboratively plans its assault with the support of on-line planning assistants. The A-team updates the building schematic with the latest available human intelligence. Using micro-sensors, the team enters the building. The special operators see the sensor information through their left eyepiece. The sensor locates a possible human heat source in the basement of the building. The A-team advances and successfully snatches the enemy commander. As the team egresses with the hostage, they interrogate the enemy commander using questions sent electronically from the supported commander. The A-team returns to their operating location for a mission hot wash – by all accounts, the team's flexibility was a key to mission success.

What is network-centric warfare?

NCW is an approach to warfare, which focuses on the greater synergistic effect that can be created by networking, and electronically linking geographically separated forces into one sensor-to-shooter engagement grid.[4] Improved battlespace awareness can be created through extending the sensing of the individual entity (aircraft or SOF operator or team) to the cumulative ability and reach of the entire network. With access to common operating information, 21st century forces can mass information, vice forces, and project combat power. As

part of a warfighting network, entities coordinate their actions by following the commander's intent and the commander's rule set which govern operations. This "rule set" provides guidelines for coordinating and controlling the interactions of the network entities. The rule set addresses who engages each target in different situations. The rule set seeks to deconflict shooters and optimize sensor coverage. By decentralizing the decision making, establishing rule sets, and providing access to the common operating information, the network accelerates observe, orient, decide, and act (OODA) loops.[5] Using the commander's guidance, the network can engage more targets as an aggregate system than the entities individually can handle. Furthermore, the network's ability to increase shared situational awareness can increase the speed of command for the entities, since for most engagements, the entities are following the commander's intent and rule set, to self-synchronize their activities and are not idly waiting for commands from military hierarchies.[6]

How does NCW increase combat power?

To the warfighter, NCW can be used to improve the operators' shared awareness and increase the chances of mission success. Even though the concept of NCW is embryonic, efforts to measure NCW have begun. A US Air Force Operational Special Project employing F-15C fighter aircraft set out to evaluate the military utility of tactical data links, i.e. the Joint Tactical Information Distribution System (JTIDS). In the evaluation, F-15C aircraft were employed against other F-15C aircraft in air-to-air operations. One side could only transmit information between aircraft via voice communications. The other flight had both the voice capability and the shared digital tactical picture provided by JTIDS, which functionally networked the aircraft. The project collected data from over 12,000 sorties and the results of the evaluation support their hypothesis that network-centric operations can increase combat power -- the JTIDS equipped aircraft increased their kill ratios for daylight and night operations by 2.61 and 2.59, respectively. The evaluation "demonstrated air crews fighting with shared awareness could increase combat power by over 100%."[7]

This network-centric theory is summarized below.

(nc = network-centric aircraft enabled with JTIDS, pc = platform-centric aircraft sharing information by voice communications only)

Improved Information Position (I):

$\mathbf{I_{nc} > I_{pc}}$ The pilots with access to the relevant, timely, and accurate JTIDS data had a superior informational advantage over the pilots with voice only communications between aircraft. JTIDS effectively extended each individual platforms sensing range by sharing the sensor data between platforms.

Increased Shared Situational Awareness (SSA):

$SSA_{nc} > SSA_{pc}$ By sharing the same common operating information between the nc aircraft, the nc fighter pilots had better shared situational awareness than their adversaries, the pc pilots.

Increased Operational Tempo (OPTEMPO):

$OPTEMPO_{nc} > OPTEMPO_{pc}$ For the nc pilots, the superior situational awareness resulted in faster OODA loops, improved command and engagement decisions.

Increased Loss Exchange Ratio (R):

$R_{nc} > R_{pc}$ Subsequently, the nc pilots increased their kill ratio over the pc enemy.

Similar experience and evidence is available to further support the findings of the above experiment.[8] The realization that increased shared awareness can improve combat power is not new, but before we address the implications for special operations, we first review a theory for the art of special operations.

McRaven's Theory of Special Operations

There are many historical recounts of special operations and many more theories on warfare. Unfortunately, there are few theories on the operational art of special operations.[9] One theory, popular within the special operations community, is Capt Bill McRaven's Theory of Special Operations.[10] McRaven uses eight historical special operations cases to deduce his theory and isolate six principles that are key for success in special operations. For McRaven, a "special operation is conducted by forces specially trained, equipped, and supported for a specific target whose destruction, elimination, or rescue, is a political or military imperative."[11] For the cases he selected, a smaller force attacking a larger force already in a defensive position characterized special operations. From analyzing these historical raids and rescues, McRaven postulates that relative superiority is a necessary condition for success. "Simply stated, relative superiority is a condition that exists when an attacking force, generally smaller, gains a decisive advantage over a larger or well-defended enemy."[12] The basic properties of relative superiority are that it is achieved at the pivotal moment in an engagement and that relative superiority must be sustained because it is difficult to regain.

In McRaven's study, special operations are narrowly defined to what we generally term today as direct action, or raids and rescues. The utility of the narrow definition is that it allowed McRaven to deduce six principles for special operations, which McRaven contends lead to relative superiority. McRaven's principles of special operations are simplicity, security, repetition, surprise, speed, and purpose. According to McRaven "a simple plan, carefully concealed, repeatedly and realistically rehearsed, and executed with surprise, speed, and purpose"[13] provides

special operators with the highest probability of succeeding. Dividing special operations into three phases serves to clarify the six principles – planning (simple), preparation (security and repetition), and execution (surprise, speed, and purpose).

Simplicity in planning is the most crucial of the six principles.[14] The three elements of simplicity are to limit the mission objectives, good intelligence, and innovation. Although the strategic objective for the mission is dictated to the special operator, the special operator can limit the number of tactical objectives for the mission. Attaining good intelligence is critical in all military planning. Good intelligence can limit the uncertainty in planning, however, intelligence gaps will always exist. But, unlike most military operations, strategic special operations, such as hostage rescues, have access to strategic intelligence assets. The final element of simplicity is innovation. Innovative planning overcomes foreseen obstacles that would otherwise inhibit surprise or increase the time special operators spend on target.

Security and repetition are the key principles during the preparation phase of the mission. In the cases selected by McRaven for study, special operators attacked forces prepared to defend fortified positions. In these cases, security was required to protect the timing of the operation, as well as the method of attack. The second principle for the preparation phase of special operations is repetition. During preparation, full mission rehearsal allows planners to identify critical areas and vulnerabilities to address or mitigate.

In McRaven's analysis, special operators, normally small in numbers, typically attack forces in defensive positions, which are generally prepared to defend. Because of this characteristic, the three key principles for the execution phase of a special operation are surprise, speed, and purpose. Surprise in these cases relates to protecting the timing and manner of attack. Since the defensive forces are being engaged, McRaven determines their will to fight is a constant. With that assertion, speed is no longer relative to whether or not the enemy will defend against your attack, but is now "a function of time, not, as some imply, a relative factor that is affected by the enemy's will to resist."[15] The third and last principle in the execution phase of the operation is purpose. The purpose of the mission must be clearly defined by the mission statement and the special operator must clearly understand and be personally committed to the mission's purpose and objectives.

McRaven concludes that following his principles of special operations increases the probability of mission success, but that the frictions of war (uncertainty and chance) will constantly act upon the special operator during the mission. McRaven, drawing on Carl Von Clausewitz's moral factors, notes that special operator's courage and commitment, although difficult to isolate and theorize, inevitably weigh heavily in determining success.

For my analysis, I continued with McRaven's definition of special operations and divided special operations into the same three phases as McRaven– planning (simple), preparation (security and repetition), and execution (surprise, speed, and purpose). For each phase (planning, preparation, and execution), I applied the concept of network-centric warfare to the principles of special operations to form the hybrid of those theories – network-centric special operations. The subsequent question I asked was this, does network-centric special operations improve the likelihood of achieving the six principles of special operations and if so will network-centric

special operations improve the probability of mission success for special operations (raids, direct action, and rescues)?

NCW's impact on McRaven's Theory of Special Operations

Planning (Simplicity)

On the surface, the concept of using simplicity to deal with planning a complex mission seems like an oxymoron, but in reality, it is a necessary condition for success. Self-synchronized operations are not the uncoordinated mêlée one may think. Like other operations, network-centric operations are coordinated and limited by doctrine, rule sets, and the commander's intent.[16] Simplicity in planning is maintained by developing simple, coherent rule sets, commander's intent, and leveraging doctrine. These coordination mechanisms allow for decentralized execution by standardizing operator performance through intensive training and simulation. Designing this guidance is the key task in the planning phase for network-centric special operations.

With regards to planning, network-centric special operations have inherent advantages and some disadvantages when compared to traditional special operations. Networked special operations forces can use the network connectivity to leverage information agencies or information clearing houses, such as Naval Special Warfare Command's Mission Support Center and other theater and national intelligence agencies, to create a collaborative planning environment. Using the network, collaborative planning can speed the process and improve the quality of the product. While the A-team is still responsible for their own operational plan, they can be assigned information gatherers to scour the network for relevant intelligence, operational material, and access to subject matter experts. Furthermore, when a special operations entity is tasked with a mission, it is possible to use the mission support center to pre-gather standard operational material so that with each mission comes an electronic mission folder of relevant information. Innovation was McRaven's third element of simplicity in planning. The ability to create innovative operational approaches should increase as the number of additional minds are added to the collaborative planning process. As the innovative use of gliders at Eben Emael indicate,[17] the link between innovation in planning, and surprise in execution is profound. Increasing the likelihood of innovation and surprise is strong evidence of the utility of network-centric special operations.

For network-centric special operations there are some new limitations to consider. In the collaborative planning process it remains imperative for the striking force to maintain planning control. The team designated to execute the mission must be "supported" in the planning process and not "directed" through the tactical level planning. It is reasonable to expect that mission support center personnel may out rank the strike force leader, but as a support unit, the mission support center must maintain a support relationship.

A reasonable concern with regard to network-centric special operations is the possibility of information overload. To avoid information overload in planning the use of advanced search engines and, most importantly, the human interaction with experienced "special operations" planners must be incorporated. To mitigate information overload during the preparation and

execution phases of a special operation, information profiles must be created for each operator. These information profiles contain standing queries and requests for information that update the operator when new information becomes available, such as new target intelligence or an updated weather advisory. Past information strategies tended to focus on information to support planning, since during execution communication connectivity was limited. Network-centric special operations use information profiles to provide relevant, timely, and accurate information both before and during operations.

Preparation (Security and Repetition)

Security in the preparation for special operations remains imperative. Without proper operational security, achieving surprise becomes increasingly more difficult. Network-centric special operations introduce new security needs that should be addressed during the execution phase of the operation. The shared situational awareness created by sharing the common operating information must be protected, both in and amongst the operators. Data link protection and emission controls become operational necessities. For example, you need to have a method to remotely take captured operators out of the network otherwise mission success may be compromised. Secondly, the levels of network traffic may provide the enemy indications of an impending attack. To negate this vulnerability, it is important to practice network deception whereby large amounts of data are sent through the network to desensitize the enemy to the real operational traffic pattern. To increase security for the special operators while on target, information listed in the information profiles can be broadcasted to the special operators, who remain in receive mode to minimize their electronic signature.

A common element between special and network-centric operations is the need for extensive repetition during preparation to improve coordination. In network-centric operations, extensive repetition will breed familiarity with the sum total of network entities. Through extensive rehearsal of the network entities, doctrinal lessons are learned and perfected. The implications for network-centric special operations are that they require extensive preparation and rehearsal, much like traditional special operations. Unlike traditional special operations, network-centric special operations find their organizational strength in the synergistic sum of its parts and the network's ability to solve and mitigate unexpected obstacles. In network-centric special operations, adaptability becomes a tenet of planning in which rehearsal and repetition focus on understanding how to prioritize the unexpected. One unintended consequence of rehearsing the most likely permutations of an operation is that it leads to an increase in rehearsal time.[18] So while network-centric special operations increase planning speed, they conversely require greater preparation time in rehearsing and exercising the network entities. Also, to properly prepare you must incorporate your information agencies into the training to realistically simulate question and answer exchanges. This causes not only increases in rehearsal time but also the number of rehearsal participants required.

Execution (Speed, Surprise, and Purpose)

The inherent informational advantage of special operations are threefold, their unique offensive nature, reliance on surprise, and speed. According to McRaven, relative superiority is a condition which exists when the "attacking force, general smaller, gains a decisive advantage over a larger

or well-defended enemy."[19] Since relative superiority is perishable and critical to success, McRaven recognizes the importance of surprise as one of his key principles.

From an informational perspective, surprise has initial informational or combat value which diminishes over time following initial contact. Surprise can take at least three forms,[20] they are doctrinal, strategic, and tactical. Doctrinal surprise can be achieved by attacking an adversary in a manner seen as unconventional or unexpected.[21] Doctrinal surprise can be profound but in many ways is a one-time advantage. Strategic surprise occurs when the enemy has no idea the raiders are operating against them. Tactical surprise is achieved when the enemy has no warning, or insufficient warning to respond to a special operation during execution. You can succeed in special operations without strategic surprise, but tactical surprise is almost a necessary precondition.[22]

The level of surprise is inherently linked to speed. In a special operation, special operations forces are trying to increase the speed of their own OODA loop and delay the time it takes the enemy to complete their OODA loop. Surprising the enemy both delays observation and inhibits the enemy's ability to orient, causing a slowdown in the enemy's OODA loop. If the special operator can exploit the enemy's disorientation by increasing the speed and efficacy of his own OODA loop, then the special operator would in theory improve his ability to succeed. McRaven describes this event as sustaining relative superiority. NCW is a concept focused on transforming greater situational awareness into increased operational tempo by decreasing the period of ones own OODA loop – this speed of command is the essence of turning network-centric operations into combat power.[23]

As a principle of special operations the value of surprise arguably remains constant but possibly harder to achieve against a network-centric opponent. Holding all other things constant, a network-centric opponent would have a greater ability to observe and orient to your actions. Thus, the importance of gaining (through security and surprise) and maintaining (through speed and purpose) the relative informational advantage becomes clear.

McRaven describes purpose as "understanding and then executing the prime objective of the mission regardless of emerging obstacles or opportunities."[24] Network-centric special operations impact McRaven's principle of purpose in two distinct ways. First, by leveraging the network's shared knowledge (the knowledge of both the special operators on target and those on the network), solutions to emerging obstacles can be identified faster. The second way network-centric special operations impact purpose is drawn from McRaven's observation that each special operator needs to be personally committed to mission success. Network-centric special operations may require greater leadership to create high levels of commitment throughout the virtual network enterprise.

With an improved network-centric situational awareness, NCW promotes adaptability in execution.[25] Using the common operating information, operators self-synchronize operations to decrease the re-act time associated with the OODA loop. At the tactical level, this transforms the traditional top-down command paradigm to a more lateral command web and results in tactics that may exhibit a "swarming effect."[26] This new operational tenet increases operational tempo and can facilitate greater combat power.[27]

Conclusions

In theory, network-centric special operations improve mission planning, accelerate our own OODA loop, expand McRaven's area of relative superiority, and can ultimately increase combat effectiveness. Network-centric special operations have inherent advantages over traditional special operations for mission planning and execution. As outlined above, the limitations of network-centric warfare are most obvious in the mission preparation phase.

The above conclusions are theoretical and academic in nature. Like the services, US Special Operations Command must move to experiment with new emerging network and information technology. Only through experimentation will the doctrinal and procedural nuances be identified and corrected.

Although this essay's analytical framework didn't address organizational issues, three organizational implications can be drawn from this cross-pollination of theories. First, special operations' striking force composition may require reexamination. A network-centric special operations force would have the ability to leverage reach-back information centers to provide needed information. This may imply a smaller front-end for future network-centric special operations forces.

Second, the shared situational awareness derived from the common operating information enables senior commanders a god's-eye-view of the operation and tends to invite their input at the tactical level. SOF, like all forces, can either learn the lessons of micromanagement in training, or as is often the case, during operations. This compression of access between senior leadership and the actual operator can best be discussed absent the heat of a real-world contingency.

Third, network-centric special operations allow special operations forces, when working in concert with conventional forces, the ability to link into the greater Joint Forces Commander's (JFC) network. With greater speed derived from networked operations, SOF can continue to provide the JFC the ability to access denied areas and extend the conventional sensor grid to facilitate faster and further reaching weapon engagement zones.

I have one final caveat about the limitations of this essay. As described in the beginning of the text, network-centric special operations inherited McRaven's narrower definition of a special operation. So the findings and thoughts contained in this paper reflect thoughts about, and limited to, strategic, short-duration special operations such as raids and rescues. Although certain characteristics of network-centric special operations, such as collaborative planning and faster OODA loops, seem relevant to other protracted special operations such as psychological operations, it was not the intent of this essay to expand the definition adopted from McRaven's study.

Notes

1. The Mission Support Center (MSC) is a CONUS-based information support center for Naval SEAL operations. The center is designed to collect, process, and disseminate an

uninterrupted flow of mission related information to SEAL teams during peacetime and wartime operations.

2. SWAMPS is an automated Naval Special Warfare's mission planning process and provides land, shipboard, and submarine-based operational and liaison elements the ability to conduct collaborative joint mission planning, information management, and operational deconfliction over SIPRNET.
3. Today, an Operational Detachment A (A-team) generally consists of 12 members with a Captain as commander. In the future, using network-centric special operations, the size and composition of the A-team becomes debatable.
4. The engagement grid is defined as the shared area of the intelligence, surveillance, and reconnaissance sensor grid and the weapons reach envelope.
5. The observe, orient, decide, and act (OODA) model, also known as the Boyd cycle, was first articulated by Colonel John Boyd, a retired Air Force pilot. The model was developed during Boyd's study of air-to-air aircraft engagements. Boyd developed the model to explain how pilots adapt to new information and translate that information into action. For further description and analysis of the OODA loop concept see Robert Bateman III, "Avoiding Information Overload," Military Review, Jul-Aug 1998 at www-cgsc.army.mil/milrev.
6. Alberts, Garstka, and Stein. Network Centric Warfare: developing and leveraging information superiority, C4ISR Cooperative Research Program, Washington D.C., 1998.
7. Garstka, John. "Network Centric Warfare: An overview of Emerging Theory." Phalanx 33:4 (December 2000): 1-33.
8. See Garstka, John. "Network Centric Warfare: An overview of Emerging Theory." Phalanx 33:4 (December 2000): 1-33 for descriptions of Fleet Battle Experiment Delta, conducted in October 1998 in conjunction with FOAL EAGLE 98, and the US Army's Task Force XXI Advanced Warfighting Experiment.
9. For a discussion on why special operations fail see Lucien Vandenbroucke's Perilous Options, Oxford University Press, 1993. Also, an excellent chapter on the strategic utility of special operations can be found in Colin Gray's book Explorations in Strategy, Penguin, 1998. Nevertheless, most books about special operations tend to be historical recounts of the operations, one useful 'historical' anthology is John Arquilla's From Troy to Entebbe, University Press of America, New York, 1996, in which the editor organizes the essays to highlight what makes special operations strategic, the importance of surprise in special operations, and the tension and utility special operations provide to conventional forces.
10. McRaven, William. Spec Ops - Case Studies in Special Operations Warfare: Theory and Practice, Presidio, Novato, CA, 1996. McRaven's eight historical cases are the German attack on Eben Emael, 10 May 1940; the Italian manned torpedo attack at Alexandria, 19 December 1941; Operation Chariot: the British raid on Saint-Nazaire, 27-28 September 1943; Operation Source: midget submarine attack on the Tirpitz, 22 September 1943; the U.S. Ranger raid on Cabanatuan, 30 January 1945; Operation Kingpin: the U.S. Army raid on Son Tay, 21 November 1970; and Operation Jonathan: the Israeli raid on Entebbe, 4 July 1976.
11. McRaven, p. 2. The Department of Defense uses a broader definition for special operations - "operations conducted by specially organized, trained, and equipped military and paramilitary forces to achieve military, political, economic, or psychological

objectives by unconventional military means in hostile, denied, or politically sensitive areas" (Joint Publication 1-02).

12. McRaven, p. 4.
13. McRaven, p. 11.
14. McRaven, p. 11.
15. McRaven, p. 21.
16. Alberts, Garstka, and Stein. Network Centric Warfare: developing and leveraging information superiority, C4ISR Cooperative Research Program, Washington D.C., 1998.
17. On 10 May 1940 German airborne personnel attacked the Belgium fortress of Eben Emael. The Germans needed to capture, or neutralize, Fort Eben Emael so that they could use the three bridges at Veldwezelt, Vroenhoven, and Canne to cross the Albert Canal. They Germans decided to use gliders to land their troops at daylight to attack the fort. The Germans gained surprise by using the glider to close with the defensive forces in a manner which the Belgians were unprepared to defend against. For further details see McRaven pages 29-73.
18. If the same special operators plan, rehearse, and execute the mission and we assume time to respond to a crisis is a given, then the expansion of rehearsal time comes at the expense of time to plan. If, as many theorists propose, the speed of warfare is increasing, then it may become necessary in future special operations to use separate individuals for planning and execution. At the operational level, the USAF uses this distribution of labor to deliver aerospace power to the Joint Forces Commander.
19. McRaven, p. 4.
20. See Arquilla, John, ed. From Troy to Entebbe, University Press of America, New York, 1996.
21. The first use of a new capability, such as the use of gliders at Eben Emael.
22. Arquilla.
23. The ability to process through the information domain faster than your enemy is what results in speed of command. It is a relative concept, not discreet. What matters is that you are faster than your enemy, not the absolute speed of your decision cycle.
24. Page 21.
25. This self-synchronization is not autonomous operations because operations are bounded by doctrine, communications, and the commander's intent. See Cebrowski, "Network-centric Warfare: An Emerging Military Response to the Information Age," This self-synchronization is not autonomous operations because operations are bounded by doctrine, communications, and the commander's intent. See Cebrowski, "Network-centric Warfare: An Emerging Military Response to the Information Age," www.nwc.navy.mil/pres/speeches/ 29 June 1999.
26. "Swarming occurs when the dispersed nodes of a network of small (and perhaps some large) forces converge on a target from multiple directions. The overall aim is the sustainable pulsing of force or fire. Once in motion, swarm networks must be able to coalesce rapidly and stealthily on a target, then dissever and redisperse, immediately ready to recombine for a new pulse." See Arquilla, Ronfeldt, and Zanini, "Networks, Netwar, and Information-Age Terrorism," p. 88, in Khalilzad and White ed, The Changing Role of Information in Warfare, RAND, Santa Monica, CA, 1999.
27. Cebrowski, 29 June 1999.

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