THE JOINT FORCES AIR COMMAND PROBLEM
Is Network-centric Warfare the Answer?

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> *The American military's biggest problem? It lets technology drive strategy, rather than letting strategy determine technology.*
>
> <div align="right">BRIG. GEN. DON MORELLI, USA (RET.)</div>

The marriage of network-centric warfare and the joint forces air component commander concept represents a "military-technical revolution" in aerospace command and control.[1] The current system is cumbersome, and it is falling behind in its ability to deal with the fast-paced warfare of today. By its nature, network-centric warfare (NCW) could address many of the shortfalls of the current joint air component system. It will not, however, change the fundamental nature of war, nor can it solve all of the current problems of the joint forces air component commander (JFACC). This article will examine the potential and limitations of network-centric warfare in terms of command and control and in the context of the JFACC.

Network-centric warfare—the "effective linking or networking of knowledgeable entities that are geographically or hierarchically dispersed"—promises to raise command and control to new levels of efficiency.[2] Conceptually, NCW provides battlespace entities with "shared battlespace awareness" through interconnectivity and networking techniques.[3] These techniques in turn allow the movement of information and decisions at rates and efficiencies previously unattainable. These "virtual organizations" can use "common operational pictures" to "self-synchronize," potentially reducing the fog and friction of war as well as shortening decision and execution times.[4] The ability to relay a common picture of the war and share information with geographically dispersed sensors, decision makers, and weapon platforms would reduce

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the time it takes them collectively to observe the situation, orient themselves to the problem, decide what to do, and act.[5] Such faster decision making would increase the flexibility, lethality, and speed of airpower.

Nonetheless, and for all that network-centric warfare promises to bring to the joint forces air component commander, there are problems that it cannot fix. Conflicts in or problems with doctrine, inadequate or convoluted command and control structures and procedures, and poor decision making will remain. In any case, it cannot change the nature of warfare. "War is an act of human intercourse";[6] the technology of NCW can go only so far to correct uniquely human problems. Additionally, limitations are likely to arise in relation to the specifics of required command and control systems, connectivity, or the validity of the JFACC concept itself. These matters are necessarily beyond the scope of this article, which assesses the likelihood that network-centric warfare can dramatically increase the efficiency and flexibility with which air warfare is conducted.

In its current form, the joint forces air component commander is the central element of the concept that (in the view of the U.S. Air Force) combines centralized command and control of air assets with decentralized execution of air warfare.[7] Under joint doctrine, the joint air commander, whose function is to control air and space power in a given area of operations, is appointed by and works directly for the joint forces commander.[8] The JFACC concept also incorporates key tenets of specifically Air Force airpower doctrine: "Air and Space power must be controlled by an airman who maintains a broad strategic and/or theater perspective in prioritizing the use of limited air and space assets to attain the objectives of all U.S. forces in any contingency across the range of operations."[9] History is full of examples of the perils of dividing up airpower assets and of the advantages of centrally controlling them.[10] The Air Force believes that parceling airpower out to various agencies and among various tasks will negate its inherent qualities of mass, flexibility, and transcendent scope—that is, its freedom from limitation by geography, water depth, road conditions, etc. The service's doctrine declares that the joint forces air component commander should be "an airman who maintains a broad and/or theater perspective," for reasons of perspective that would become particularly relevant with the advent of network-centric warfare.

THE ISSUES
As a preliminary to evaluating NCW's potential contribution, it is important to understand the problems and issues of the current organization and tasks of joint forces air component command. Most prominent are a myriad of

difficulties arising from centralization: most of the functions for which the joint air commander is responsible—planning, coordinating, allocating, tasking, and executing air operations in accordance with the joint forces commander's objectives—are conducted in a single air operations center.[11] The first of this category of issues is that the concentration of tasks makes the air operations center (or AOC) a critical—and vulnerable—node in the command and control of a major element of U.S. military forces. Its destruction would virtually cripple air operations. All of the air operations center's functions are singular; there are no backups for them. The system has no "redundancy" in this respect; it cannot deal with a loss of the AOC.

Second, due to its size—it has a staff of roughly 1,300 and considerable equipment and other infrastructure—the air operations center is both cumbersome and difficult to move. Deployment requires a substantial logistical effort.[12] The large "footprint" of an air operations center also puts a premium on physical plant; AOCs must now be housed in large, hardened facilities. Any sensitivity of host nations to the presence of a large number of Americans and representatives of U.S. coalition partners adds to the problems of locating the center.

In addition, the AOC's large size makes it difficult to establish aboard a ship. The absence of the sea-basing option in a world in which suitable facilities ashore may not be available is a serious limitation. An afloat joint forces air component commander would enjoy greatly increased flexibility, especially in situations in which the Navy provides the preponderance of airpower.[13]

The current structure is also inflexible with regard to contingencies and circumstances. The war in Kosovo highlighted this deficiency. As the Defense Department later reported to Congress, "Operation Allied Force highlighted the need for the Department to develop expeditionary air operations centers and equip them with supporting resources and manpower to enable U.S. forces to create combined air operations centers that can be tailored to the crisis at hand and deployed quickly."[14]

Under the current structure, the command and control of aerospace power resides by definition in a single person. The amount of information and the scope and rapidity of decision making involved in planning and executing an air campaign is enormous, far beyond the physical capabilities of any one human being.[15] In practice, the bulk of this effort is shouldered by the air operations center staff. However, the commander, in person, remains the final authority—and is therefore a single point of failure. If the joint air commander were somehow removed from the battle, the ramifications could be catastrophic.

A final problem related directly to centralization is that keeping an air operations center staff trained for its wartime functions is a mammoth task. Command and control involves perishable skills that atrophy in the absence of training. The experience of ULCHI FOCUS LENS, a joint and combined command

and control exercise series conducted by the Seventh Air Force in the Republic of Korea, is illustrative. To assume its wartime configuration for these evolutions, the Seventh Air Force's air operations center requires hundreds of augmentees from other commands. Many more people are needed just to run the simulation and represent the roles of the various coordinating entities. An exercise like ULCHI FOCUS LENS is productive and effective, but it is expensive and time consuming, and it meets the training needs of only a single JFACC.

Aside from the specific problems caused by the centralized nature of the current structure, there are fundamental weaknesses in several basic procedural areas. A number of processes that have been reasonably effective in the past are no longer able to meet the demands of modern warfare.

The first of these is the air tasking order, the single-source plan for all air operations in an area of operations in a twenty-four-hour period. The air tasking order assigns to individual units their targets, weapons, and arrival times over those targets. Second, it tells all "players" what will be going on around them as they execute their missions; this "deconfliction" is critical to the execution of aerial operations, to avoid fratricide and

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duplication of effort and increase the safety of flight. Already, however, a given day's air tasking order takes anywhere from thirty-six to forty-eight hours to produce.[16] By the time the order is issued, the majority of its assumptions, analyses, and targeting decisions are out of date.

A second issue is that of target recognition and identification, one of the most severely limiting factors in the high-speed warfare of today. The need for speed is particularly critical in the prosecution of "time-sensitive" (that is, moving) surface targets. The problem they represent is not new but is receiving increased visibility in light of the proliferation of weapons of mass destruction, mobile surface-to-air missile launchers, and theater ballistic missiles. Too often, by the time the target is analyzed and identified, it is no longer visible. The limiting inherent factors in the prosecution of fleeting targets are the processes of detection and identification. Current technology has not caught up with requirements; these tasks are not being performed rapidly enough. Another vital piece of the identification puzzle is the threat of fratricide. In DESERT STORM, coalition forces suffered 107 casualties to friendly fire.[17] In a casualty-conscious world, and for a technologically advanced military, this is unacceptable.

This litany of problems with the joint forces air component command structure of today, as long as it is, is not all-inclusive. There are other problems, such as service doctrine disputes, connectivity, and joint integration. Network-

centric warfare cannot address them; however, it has great potential to bring improvements to the particular problem areas we have discussed.

WHAT NETWORK-CENTRIC WARFARE CAN DO FOR THE JFACC

Network-centric warfare's major contribution in the arena of command and control will reside in its ability to assimilate large amounts of data, translate the data into coherent and useful information, and provide conduits that allow the key decision makers to communicate and collaborate at speeds currently unrealized and then quickly pass their decisions to weapon platforms. Additionally, NCW will distribute shared "awareness" to all battlespace entities. It is these qualities that must be capitalized upon if the current shortcomings of joint forces air component command are to be alleviated.

By its very nature, the connectivity NCW provides permits decentralization of the joint forces air component command infrastructure. Networking would enable a "virtual" air operations center;[18] its functions would no longer need to be collocated. The vulnerability of the AOC would be reduced, and therefore that of the command and control system as well—it would no longer have a single "pressure point." A geographically dispersed system is, by nature, less susceptible to attack and collapse. Additionally, networking would allow for parallel operations, and thus for redundancy at critical nodes. For example, an alternate joint air commander and staff, themselves geographically distributed, might monitor operations; should the JFACC be forced to move or be lost in combat, the alternate could take over operations seamlessly. Single-point failures could virtually be eliminated; the robustness of such a system would be invaluable as the intensity of warfare increases.

The ability of NCW to decentralize functions also makes possible "reachback," by which functions could be located in relatively safe locations, perhaps the continental United States.[19] Even well to the rear, such functions remain on the network, connected to all the other nodes. The ability of an air operations center simply to "reach back" to a Defense Department agency, say, for support would yield several benefits.

First, it would reduce the size of the center's staff. The fact that not all segments of the AOC staff deploy would mean less equipment, fewer people, and a smaller support base to be moved forward. This in turn makes the air operations center more able to use austere facilities. It also minimizes U.S. and coalition presence on foreign soil.

Second, the joint forces air component commander could move aboard ship. As we have seen, JFACCs are currently hindered from moving to sea by the size of their staffs and the command-and-control systems they require.[20] Afloat operations are advantageous for several reasons in addition to those already noted.

In a given situation, a carrier battle group may be first on the scene; when the main focus of effort shifted toward the land, the transition to a shore-based joint air commander would be greatly eased if an organization were already functioning at sea. Afloat operations may not always be the option of choice, but network-centric warfare promises to make them a viable option.

Third, NCW-based reachback would allow specialized agencies to participate effectively in forward operations. In so complex an undertaking as national security, pockets of special expertise and capability inevitably emerge. Such organizations such as the Joint Warfare Analysis Center, the Defense Threat Reduction Agency, CHECKMATE, and many others provide unique "skill sets" in vital disciplines.[21] However, in an era of reduced manning and uncertain budgets, they are less and less able to send forward fully capable detachments to support staffs in combat areas; network-centricity would allow joint air commanders and their staffs to tap such expertise at its various sources, rapidly, efficiently, and as they need it; networking would also allow air operations centers to delegate some of their workloads.

As an example of the force-multiplying effect of rear-area expertise in the planning and execution of air warfare, take the case of hardened, deeply buried targets, today an emerging "target set." Vital enemy command-and-control and weapons-of-mass-destruction facilities are typically protected in this way. Locating them and gathering and analyzing intelligence on them are difficult and time-consuming tasks. Network-centric organization would allow data to be sent, for instance, to the Joint Warfare Analysis Center, which possesses the specialists and analytical tools necessary to discern whether valid targets have been found and if so, to determine the best way to attack them. Their solutions will probably be of better quality than those air operations centers could produce themselves.

Finally, no two scenarios are the same, a reality that places a premium on the flexibility of an air operations center. Not all components of the notional AOC structure are needed in all situations. Network-centric warfare would allow the joint forces air component commander to tailor a virtual organization to the task at hand. By virtue of such NCW fundamentals as reachback and networking, only organizations necessary for a given mission need be "brought to the fight." This point is particularly relevant for such major headquarters as regional commands; indeed, the current crisis management philosophy of European Command is to build joint task forces from the ground up, tailoring them to meet particular crises.[22] This approach represents a marked departure from the traditional concept of standing task forces and air operations centers;[23] network-centric warfare should give regional and joint task force commanders the ability to form trained air component command structures on short notice.

Network-centric warfare will mitigate a subtle danger inherent in reliance upon a centralized decision-making entity—the equating of the concepts of "command" and "control." They have been inexorably linked for years, but they are very different notions. Command has been defined as "the exercise of authority and direction by a properly designated commander over assigned forces in the accomplishment of the mission."[24] "Control," joint doctrine declares, "is inherent in command."[25] Even so, "control" embraces the "procedures employed by a commander in planning, directing, coordinating, and controlling forces and operations in the accomplishment of the mission."[26] In short, command is *authority,* and control is a *process.* Ultimately, command authority over a joint force's air and space assets rests with its air component commander; network-centricity will significantly enhance the JFACC's ability to exercise it. Improved connectivity with subordinates will enhance the joint air commander's ability to "direct people and organizations into actions to accomplish missions."[27]

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Networking will also allow joint forces air component commanders to delegate control more effectively. The primary rationale in the past for centralized command and control was that generally only the commander had "the whole picture."[28] NCW makes it possible to extend, to levels not previously feasible, "distributive control"—delegation of responsibilities and processes to levels or organizations best suited to them—and thereby achieve not only lessened vulnerability but faster decision cycles and operational tempos. In a network-centric force, vital information is distributed to all appropriate levels of control, depending on the mission; experts in particular disciplines—given the knowledge and authority required to assess, decide, act, and control—can achieve smaller and more efficient response cycles than were ever before possible.

Properly trained subordinates, with clear and firm guidance from the joint forces air component commander, will be informed and connected decision makers. In a network-centric system, however, the onus is on commanders to ensure that a correct understanding of their overall intentions and the objectives of particular operations pervades the control structure. "Mission-type orders"—telling subordinates what needs to be done, not how—issued through a network in conjunction with air tasking orders will provide control elements the guidance they need.[29] Properly designed and reinforced by education, training, and doctrine, centralized command and decentralized control would allow the joint forces air component commander to employ aerospace power with maximal effectiveness.

Training, however, as we have pointed out, is one of the most pressing short-comings of air component command. The level of skill in the command and control of aerospace power is presently inadequate.[30] Here again, network-centric concepts would bring in a new era.

The current effort in the Air Force to eliminate the expertise problem is the "AOC as a Weapons System" program.[31] The concept is to make the training of members of centers mirror that given for weapon systems, such as fighters and bombers. AOC staffs will be required to maintain complex qualifications commensurate with their wartime roles. Presently, initial training is given at the Command and Control Warriors School, a division of the Command and Control Training Innovations Group at Hurlburt Field, Florida.[32] Final mission-qualification training is accomplished within the assigned air operations centers. The current major deficiency is fidelity; interactions with agencies that are geographically distant or not manned in peacetime must be simulated. Network-centric organization, because it would keep the entire virtual AOC connected at all times, would raise the frequency and quality of training.

Theoretically, virtual battles can be fought within the existing network;[33] however, that involves large, cumbersome, off-board computer systems, such as a system known as the Air Warfare Simulator. NCW architecture would allow higher-fidelity training by connecting existing systems so as to replicate an actual battle space.[34] Its "virtual environment" capabilities could simulate battle spaces within the architecture of the system.[35] Since all involved entities would be connected to the system anyway, deployments of masses of people and equipment to support training would be eliminated. Network-centricity would improve the realism and value of war gaming and training, at a great reduction in cost.

This capability would also mean that more people could be trained per unit of time in AOC operations. Since airpower is an inherently joint endeavor, combined and joint training is crucial. With the necessary equipment, allies and other services could train in the virtual environment. Joint forces air component commanders of other services—anywhere, including aboard ship—could train with a virtual air operations center. In the process, joint air commanders could tailor their organizations and think out exercising lines of communication, command-and-control relationships, information flows, and decision-making processes in advance. Air operations centers should not be limited to ad hoc, "come as you are" responses to crises; network-centric warfare can bring this principle to reality.

One of the fundamental characteristics of network-centric warfare—flexibility through ability to share battlespace awareness—can directly address one of the most cumbersome and inflexible aspects of the current joint air

component system, the air tasking order. As noted earlier, production of ATOs is a lengthy process. Because they represent an entire theater's air effort, they can be over nine hundred pages in length.[36] NCW offers a more responsive and less burdensome approach. Shared battlespace awareness, in the form of a common operational picture, would already be available to all players; in fact, they would have a degree of situational awareness not previously possible. Tasking could be transmitted to individual subordinates, in plain view of all interested parties. Because the orders could therefore be timelier, they could better reflect changing battlespace situations. Additionally, fratricide could be virtually eliminated. Because all commands would possess a real-time and accurate "picture" of the battle space, even in the heat of battle they would be able to identify definitively their targets prior to engaging them; their displays would alert them if they were about to engage a "friendly."

Further, a well-fused picture would bring improvements to another area we have mentioned as a weakness: the detection, identification, and prosecution of time-sensitive surface targets.[37] The necessary advances—more responsive tasking of intelligence, surveillance, and reconnaissance assets; rapid sharing and analysis of the raw information; and transmission of high-fidelity, "targetable" data to a weapon platform in time to use it—will be hallmarks of network-centric warfare.

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The prosecution of moving surface targets and theater missile defense (TMD) have many information needs in common, including timely detection, accurate analysis and identification, and immediate communication with weapons systems capable of engaging targets. In a networked environment, there is no necessity, as now, to compete for this information (which might be closely held by agencies for classification or bureaucratic reasons); it can be shared between and collaborated on by people not necessarily at the same location. Such collaboration in real time constitutes "self-synchronization," a prerequisite for the quick and efficient prosecution of such difficult but important targets.[38] Agencies and commands specializing in moving ground targets and TMD, respectively, can collaborate not only in analysis but in selecting the best means to strike the target. A weapon platform normally assigned to one of these functional areas can be used to attack a target of the other. With the proper delegation of control, both surface and theater-missile targets could be disposed of with rapidity not possible today.

WHAT NETWORK-CENTRIC WARFARE CANNOT DO

For all of the capabilities that NCW could bring to joint forces air component commanders and their air operations centers, there are several things that cannot be expected from it. Above all, NCW cannot replace people. Warfare is a uniquely human endeavor. Technology can allow war to be waged more efficiently but cannot change its nature. In the very nature of things, human judgment will always be required in the planning and execution of operations in wartime: "Human flexibility and common sense transcend the realm of logic."[39] Such intangibles as personal experience, intuition, insight, and charisma will always be prerequisites of effective leadership. Network-centric warfare can certainly aid in the decision-making process, but it cannot replace the decision maker. Let us take a historical, and dramatic, example.

Shortly after the U.S. Ballistic Missile Early Warning System (BMEWS) came on line, it detected what appeared to be a launch of intercontinental ballistic missiles from the Soviet Union. A committee instantly convened to determine whether an attack was actually in progress. One of its members recalled that the Soviet premier, Nikita Khrushchev, was in New York at the time. It seemed highly unlikely the Soviets would launch an attack with their leader so exposed; the committee accordingly decided that what looked like a Soviet missile launch was not. It was later determined that the powerful BMEWS radars had been receiving returns from the moon. This possibility had not been anticipated, and the BMEWS software had erroneously interpreted the indications as a missile launch.[40] Not every contingency can be imagined when systems are being developed; human decision makers must be the final authority.

Another problem from the human perspective is information overload.[41] Network-centric organization, if not properly regulated, can actually add to the friction of war by inundating decision makers with data. A related danger is blind trust in technology, the common perception that data from a machine must be accurate. Some commanders tend to discount human analysis and act instead on the basis of "infallible" computer-derived solutions.[42] Obviously, machines are fallible, because the people who design, produce, and program them are fallible. Information technology cannot "heal" itself of bad logic or flawed data. Consequently, caution must be exercised; too much of the wrong information can be more dangerous than too little of the right information.

Further, network-centric warfare will not change the principles of sound command. There is a tendency among senior commanders to extend their direct control to lower and lower levels. One reason is that all senior commanders were once commanders at lower levels, and some of them feel they know those jobs better than the people now in charge there. NCW can, in fact, facilitate micromanagement at levels and to degrees never before attainable. With instant

connectivity with all players and a resultant false sense that they know everything about every aspect of the battle, commanders and senior civilian authorities may be tempted more strongly than ever to assert themselves in inappropriate ways. In the words of a former commandant of the Marine Corps, General Charles C. Krulak, "Molecular management of our forces is not the school solution."[43] Only trust of subordinates, gained through education, proper doctrine, and training, can lessen this problem.

The air operation over Kosovo was by far the most "connected" conflict the United States has yet fought.[44] As such, it provides a glimpse of the potential dangers inherent in network-centric warfare, by highlighting the miscarriages that are already possible. Stories are told of strategic and operational commanders directing at the tactical level. For instance, the Supreme Allied Commander, Europe had in his office a terminal that allowed him to view what Predator unmanned aerial vehicles in the air were seeing.[45] During one mission, three vehicles that looked like tanks appeared on the supreme allied commander's screen. He picked up a telephone, called the joint forces air component commander, and directed that those tanks be destroyed.[46] With a single call, based on incomplete information, all the levels of war, from strategic to tactical, had been short-circuited.

Top-down control exercised to this extreme is potentially quite dangerous. As we have seen, the volume of information that is and will be available during combat situations is beyond the ability of one person to grasp. It is for this reason that Air Force doctrine calls for unity of command and requires the joint forces air component commander to "maintain a broad and/or theater perspective."[47] Network-centric organization cannot be allowed to obviate this fundamental requirement.

Network-centric warfare seems to possess the peculiar and unfortunate quality of magnifying the consequences of bad doctrine and bad decisions. Ironically, the formal and cumbersome processes of command and control served in the past to dampen and somewhat mitigate such effects. In World War II, Adolf Hitler was very much involved in his army's day-to-day battles. Thinking that he knew what was going on at the front—that the radio, teletype, and telex were giving him up-to-the-minute reports—Hitler would send detailed orders. In fact, however, there was an inherent and substantial time lag in the reporting system. By the time his orders were received back at the front they had typically been overtaken by events and simply added to confusion. By default, field commanders who were effective in combat made the necessary decisions. Those who waited for Hitler's delayed guidance or tried to implement it after the fact were crushed by the enemy.[48]

TRAINING, SPEED, TRUST, AND EFFICIENCY

From the foregoing analysis, several recommendations can be made. The first is that advantage be taken of network-centric concepts to make the air operations center lighter, less centralized, and more flexible. The need to deploy air operations centers rapidly into dynamic and unanticipated situations mandates this. The constructs of expeditionary warfare need to be applied to command and control systems and architecture. It can be accomplished through reachback and networking, as already described.

Second, in a NCW environment, the concept of "control" needs to be reevaluated as something separate from "command." The argument that control needs to be restricted to higher headquarters because only they have all pertinent information is no longer valid. Network-centric warfare promises to make a common operational picture available at all levels of control. This distributed knowledge, allowing all commanders to distribute a sense of their purposes equally widely, will allow control of assets at lower levels. That, in turn, will speed the decision-making process.

Third, NCW should be used to train JFACCs and their staffs "jointly." Networking geographically dispersed entities and services will enable robust and realistic training scenarios at a fraction of the cost of today's single-location exercises. It will become practical to exercise command-and-control structures more often and across service boundaries. Such training, in the air-component community, will serve three purposes: it will allow commanders to prepare their staffs to respond properly in time of crisis; it will develop and inculcate doctrine and resolve interservice disputes; and it will enable organizations to train as they will fight. In this way trust and confidence will be built among joint forces air component commanders and their staffs, and also among higher authorities toward their subordinates. This trust and confidence should reduce the temptation to micromanage; as Air Force service doctrine states, the focus of the joint forces air component commander needs to remain at strategic and operational levels.[49]

Finally, the development of network-centric systems needs to focus on making the control of airpower more efficient. The air tasking order process needs to be replaced. The moving surface target problem needs to be solved. In general, joint forces air component commanders and their operations centers need to operate with greater speed and efficiency. Properly developed, network-centric warfare will allow all these things to happen.

The application of network-centric principles to the joint forces air component commander concept would represent a large leap ahead in the command and control of air assets. Many of the shortcomings of the present system could be resolved using NCW principles and technology; others could not be. However,

the truly important goal is to prevent technology from driving theory. Technology represents capabilities, present and future. It is not enough to say, "What can technology do?" We must ask, "What do we *need* it to do?" Network-centric warfare is a tool; if it is to be useful, it must have a defined purpose. There must exist well-thought-out doctrine to guide its development. We have discussed here possible first principles by which to shape the evolution, and initiate the integration, of network-centric warfare and the joint forces air component commander.

NOTES

1. Andrew F. Krepinevich, Jr., "The Military-Technical Revolution: A Preliminary Assessment," July 1992; excerpted in *Air Command and Staff College Distance Learning* (ver. 2.2) CD-ROM (Maxwell Air Force Base [hereafter AFB]: ACSC/DLO, 1999). "A military-technical revolution occurs when the application of new technologies into military systems combines with innovative operational concepts and organizational adaptation to alter fundamentally the character and conduct of military operations. Therefore, such revolutions are characterized by technological change, military systems evolution, operational innovation, and organizational adaptation. These elements combine to produce a dramatic improvement in military effectiveness and combat potential."

2. David S. Alberts, John J. Garstka, and Frederick P. Stein, *Network Centric Warfare,* 2d rev. ed. (Washington, D.C.: CCRP, 1999), p. 6.

3. "Battle space" is defined by the Joint Staff as "the environment, factors, and conditions which must be understood to successfully apply combat power, protect the force, or complete the mission. This includes the air, land, sea, space, and the included enemy and friendly forces, facilities, weather, terrain, the electromagnetic spectrum, and the information environment within the operational areas and areas of interest." Joint Chiefs of Staff, *Department of Defense Dictionary of Military and Related Terms,* Joint Publication 1-02 (Washington, D.C.: 23 March 1994, as amended through 14 June 2000), p. 74. The entities referred to in this article are the sensors, decision makers, and actors involved in

the conflict. It is the integration and interaction of these three entities that define "OODA loops" of combat force employment. NCW defines these functions in terms of grids: "The information grid enables the operational architectures of sensor grids and engagement grids"; Arthur K. Cebrowski [Vice Adm., USN] and John J. Garstka, "Network-centric Warfare," U.S. Naval Institute *Proceedings,* January 1998, p. 33. (The concept of the "OODA [Observe, Orient, Decide, and Act] loop" is attributed to the late Colonel John Boyd, USAF, who framed it to argue an enemy can be defeated by achieving a faster decision cycle.) For battlespace awareness, see Alberts, Garstka, and Stein, p. 115.

4. The "common operational picture" that emerges from the fusion of all available information on the battle space provides a unified, functional, and cohesive representation of events to all entities involved in operations. For self-synchronization, Alberts, Garstka, and Stein, p. 175.

5. Joint Chiefs of Staff, *Joint Doctrine Encyclopedia* (Washington, D.C.: Joint Staff, 16 July 1997), p. 221.

6. Carl von Clausewitz, *On War*, ed. and trans. Michael Howard and Peter Paret (Princeton, N.J.: Princeton Univ. Press, 1984), p. 149.

7. This is an Air Force view of the JFACC. Other services do not agree. Joint doctrine calls only for the centralized planning of airpower, to ensure unity of effort, followed by decentralized execution; see Joint Chiefs of Staff, *Command Control for Joint Air Operations*, Joint Publication 3-56.1 (Washington, D.C.: Joint Staff, 14 November 1994), p. I-2. According

to joint doctrine, authority is delegated to the JFACC by the regional commander or joint task force commander, in accordance with mission requirements. The Air Force view is pertinent here in that it is the basis for JFACC operations under way today. Every JFACC since the Persian Gulf War has been an Air Force officer.

8. Joint Publication 3-56.1, p. I-2.

9. Secretary of the Air Force, *Basic Air Force Doctrine*, AFDD 1 (Maxwell AFB, Ala.:, September 1997), p. 23.

10. Phillip S. Meilinger, "Ten Propositions Regarding Airpower," *Airpower Journal,* Spring 1996, pp. 66–7.

11. Joint Publication 3-56.1, p. II-3.

12. U.S. Dept. of Defense, *Report to Congress: Kosovo/Operation Allied Force After-Action Report* (Washington, D.C.: 31 January 2000), p. 45.

13. Joint Publication 3-56.1, p. II-8.

14. U.S. Dept. of Defense, *Report to Congress,* p. 130.

15. Thomas P. Coakley, *Command and Control for War and Peace* (Washington, D.C.: National Defense Univ. Press, 1992), p. 103.

16. James A. Winnfield and Dana J. Johnson, *Joint Air Operations: Pursuit of Unity of Command and Control, 1942–1991* (Annapolis, Md.: Naval Institute Press, 1993), p. 110.

17. Michael R. Gordon and Bernard E. Trainor, *The Generals' War* (Boston: Little, Brown, 1995), p. 457.

18. Alberts, Garstka, and Stein, p. 38.

19. William C. Martel, ed., *The Technological Arsenal: Emerging Defense Capabilities* (Washington, D.C.: Smithsonian Institution Press, 2001). For reachback, see Scott M. Britten, "Directing War from Home: Reachback Operations."

20. While the Navy has conducted exercises, such as Joint Task Force Exercise 99-1, to explore the viability of an afloat JFACC, until all required functions are networked sea-based JFACC operations will be limited. In the meantime, NCW promises to ease many of the current limitations.

21. CHECKMATE is the Air Force's premier air planning staff; it is currently located in the Air Staff at the Pentagon. It was the CHECKMATE staff, under Colonel John Warden, that laid the foundations for the air operations of DESERT STORM.

22. Robert D. Chelberg, "EUCOM: At the Center of the Vortex," *Field Artillery,* October 1993, p. 14.

23. Air operations centers are currently standing organizations in fixed locations. (There are two exceptions: Fourteenth Air Force, at Davis Monthan AFB, Arizona, and Pacific Air Forces Headquarters, at Hickam AFB, Hawaii, maintain minimally manned AOCs.) They are not manned at wartime levels.

24. Frank M. Snyder, *Command and Control: The Literature and Commentaries* (Washington, D.C.: National Defense Univ. Press, 1993), p. 11.

25. Joint Chiefs of Staff, *Doctrine for Joint Operations*, Joint Publication 3-0 (Washington, D.C.: 26 February 1995), p. II-15.

26. Snyder, p. 11.

27. Joint Publication 3-0, p. II-15.

28. Meilinger, p. 66.

29. Joint Publication 1-02, p. 299.

30. Chuck Paone, "Combined Air Operations Center Features Hanscom, Air Combat Command Teams," 31 October 2000, on the World Wide Web at afmc-mil.wpafb.af.mil/ organizations/HQ-AFMC/PA/news_sou/ 00news [2 February 2001].

31. Ibid.

32. For more information concerning curriculum, class availability, etc., visit the Command and Control Training Innovations Group Website at www.c2tig.af.mil.

33. Alberts, Garstka, and Stein, p. 167.

34. The Air Warfare Simulator is currently used in Korea to exercise the Seventh Air Force AOC during ULCHI FOCUS LENS exercises.

35. Virtual organizations vary from conventional ones in that they may be geographically dispersed but electronically connected or networked. This concept is central to network-centric operations. Virtual organizations can "leverage" sensor, information, and engagement grids to apply and control combat power at speeds never before attainable.

36. John M. Fawcett, Jr., "The JFACC Team," on the World Wide Web at www.searchmil.com/ cgi-bin/search.dllc=309890 [4 Oct 2000].

37. One of the critical components of the common operational picture is the need to "fuse" the varied inputs into one picture. If conflicts and differences between reports from sources are not resolved, the same object may show up as more than one target.

38. Alberts, Garstka, and Stein, p. 175.

39. Coakley, p. 91.

40. Ibid., p. 83.

41. Ibid., p. 78.

42. Ibid., p. 74.

43. Charles C. Krulak, "Doctrine for Joint Integration," *Joint Forces Quarterly,* Winter 1996/ 97, p. 21.

44. U.S. Dept. of Defense, *Report to Congress,* p. 46.

45. Predator is an unmanned aerial vehicle used for reconnaissance. It employs a secure datalink to relay its electro-optical picture back to ground stations. Repeater terminals, which can be placed virtually anywhere, display real-time imagery of what Predator is detecting.

46. Lt. Gen. (Ret.) Michael Short, former joint forces air component commander for Operation ALLIED FORCE, interview by author, 9 January 2001, Naval War College, Newport, R.I.

47. AFDD 1, p. 23.

48. John Keegan, quoted in Thomas P. Coakley, *Command and Control for War and Peace* (Washington, D.C.: National Defense Univ. Press, 1992), pp. 84–5.

49. AFDD 1, p. 23.