Command and Control Evoluti

By John T. Correll

The conduct of war was essentially a local affair until electronics and airpower changed the game.

To command and control his army, Napoleon went with his soldiers all the way to Moscow and back.

Painting by Adolph Northen

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Command and control, as the term is generally understood today, is a relatively new concept in warfare. It will not be found, for example, in Napoleon's Principles of War. To control military operations in Napoleon's day, the commander had to be present in the battle area. Napoleon went where his army did, all the way to Moscow in 1812.

Battle was essentially a matter of firepower and maneuver. Sometimes the cavalry could discover useful information about the enemy. Sometimes not. Communications were slow, often measured in days if not weeks. Andrew Jackson's famous defeat of the British in the Battle of New Orleans, Jan. 8, 1815, happened more than two weeks after the Treaty of Ghent was signed in Belgium to end the war.

By 1850, telegraphy made it possible to send messages over long distances but its reach was limited by the availability of lines and poles. It was not until the 20th century that the combination of electronic technology and airpower provided the means to communicate with the force wherever it was, collect information, interpret it, and use it for command and control at all levels of war.

As recently as World War II, the conduct of war was in many ways a local proposition. Messages could be exchanged between headquarters and distant locations, but headquarters seldom had timely information. The standard practice was to assign broad objectives and wait for after-action reports.

The Army relied on the concept of "mission command" in which orders provided only enough detail to establish intent and objective. Local commanders took it from there. Similarly, the Army Air Forces in World War II developed the tenet of "centralized control-decentralized execution" but mainly took it to mean that airpower should be controlled by airmen, not ground commanders. The broader and more important interpretation did not evolve until later.

The introduction of radar in the Battle of Britain in 1940 was a major milestone, but the big breakthrough in command and control came in the 1950s with data-crunching electronic computers that rapidly sifted and merged information inputs from multiple sources. The 1980s brought another pivotal development, digital data links that allowed a network of users to receive and share information.

There was a running quandary about what to call the growing function. The terminology evolved from command and control to "C3" (adding communications) to C4ISR (command, control, communications, computers, intelligence, surveillance, and reconnaissance).

Today, the superscript and two of the Cs have mostly been eliminated. The prevailing usage is C2 rather than C4 and ISR is generally treated as a separate but related subject.

In the 75 years since World War II began, command and control has become a critical factor in war, as important as the weapons themselves. The current USAF vision statement, adopted in 2013, recognizes five core missions. One of them is command and control; another is intelligence, surveillance, and reconnaissance.

The demand for ISR is so great that the Air Force strips money from other parts of the budget to provide it. The technology is so good that it has created its own danger: the temptation to micromanage from afar, dubbed

USAF photo by SSgt. Bian Ferguson

An Air Force MQ-9 Reaper comes in for a landing during Operation Enduring Freedom. Widespread employment of such remotely piloted aircraft began with the RQ-1 Predator and the streaming video it sent back to the CAOC. Armed RPAs, such as the Reaper, deliver not only reconnaissance and intelligence but deadly firepower.

"reachforward." Accordingly, Air Force leaders make a special point of maintaining "decentralized execution."

DAWN OF THE TECHNOLOGY

In the opening hours of World War I in 1914, a British ship fished up and cut five of Germany's trans-Atlantic cables in the North Sea. Two weeks later, they cut Germany's last cable, between Africa and Brazil, and hauled away a 30-mile section of it. For the remainder of the war, the Germans had to rely on the new technology of "wireless," or radio, for overseas communication. The British promptly intercepted the signals and figured out how to decode them.

Both the radio and the airplane made their combat debut in World War I but they were not advanced enough for real command and control. The radios were big and heavy, and it was difficult to shield them from interference from the airplane engine. Reconnaissance pilots found it easier to drop a handwritten note by parachute in a tube or pouch. Radios did not become standard on military airplanes until the 1930s.

The printing telegraph, also known as the teleprinter or teletype, came into use between the world wars, but the military networks were not extensive. Contact with many locations depended on the radioteletype, which connected two or more electromechanical teleprinters by radio rather than a wired link.

Military operations of the 1930s did not require elaborate command and control and the armed forces did not expend much time and money on it. The famous story of the last Pearl Harbor war warning illustrates the weakness of military communications as World War II began.

Messages, including several previous "war warnings," had been flowing back and forth for weeks between Washington and the military commanders in Hawaii. However, on the morning of Dec. 7, 1941, Gen. George C. Marshall, the Army Chief of Staff, scribbled a final such warning for Lt. Gen. Walter C. Short, commander of the Hawaiian Department.

Just before noon—which was 6:30 a.m. in Hawaii, which was on a half-hour time zone—the note was given to the War Department signals center for dispatch "at once" by the "fastest safe means." The security of the scrambler telephone was suspect and atmospheric conditions were interfering with the Army's own lines to Hawaii.

Consequently, the message went by Western Union commercial service. It reached Honolulu at 7:33 a.m. local time (22 minutes before the attack) but was not delivered by the motorcycle messenger until 11:45 a.m. After decoding, it was handed to Short's adjutant at 2:58 p.m.

It made no real difference, of course. There had been previous war warnings and besides, commanders in Hawaii knew as much about the situation as Washington did. The significance was in what it revealed about the state of military command and control.

THE WORLD WAR II EXPERIENCE

In 1940, radar was the critical factor that enabled the Royal Air Force to beat the odds and defeat the Luftwaffe in the Battle of Britain. Radar sites along the coast fed reports into the RAF command center near London, which then directed Spitfire and Hurricane fighters to meet the attack at the most effective time and place.

Although radar was used to advantage by both sides throughout the war, coverage was limited by its inability to see beyond the curvature of the Earth. The horizon was only about 15 miles away.

Longer-range aircraft allowed deep reconnaissance, but it did not always occur. When the US Ninth Air Force made its big attack on the Romanian oil refineries at Ploesti in 1943, there was no reconnaissance ahead of time for fear that an overflight would alert the enemy. Thus the bomber crews did not know that the Ploesti defenses had been improved to include 250 first-line aircraft and more anti-aircraft guns than were deployed around Berlin.

More than half of the B-24s that took off for the mission were lost over the target area or so damaged that they never flew again.

Long-range communications developed gradually. The Army Command and Administrative Net moved westward from Hawaii to Australia, India, New Guinea, and eventually the Philippines. Stations in north Africa were added to those in Britain. The air forces had their own supplementary network, the Army Airwaves Communications System.

For security reasons, wire was preferable to radio and was used extensively within the United States, but radio was the only option to connect with overseas terminals. In 1943, the

land line operation went as far as San Francisco. West of there, messages went by radioteletype.

In the first part of the war, the network was slow and overloaded, with delays of hours or sometimes days in getting messages through to field commanders and receiving answers. By 1945, the system was handling an average daily load of about 50 million words, and the links included a terminal in the President's train as it moved around the country. Eventually, secure voice communications improved enough for Allied leaders to talk to each other regularly over long distances.

Early on, the United States broke the Japanese imperial code and the British decrypted the German communications system. As in World War I, the Allies were able to read the enemy's mail.

SAGE AND ITS FRIENDS

Nuclear weapons brought new imperatives for command and control but the armed forces were slow to react. The Air Force, responsible both for delivery of the atomic bomb and air defense, was more interested than the other services and set up a command post in the Pentagon in 1950. There was a direct phone line to the White House. It was the closest thing to a national command post until the Joint War Room was established in 1960, expanding into the National Military Command Center in 1962.

In 1956, the Defense Department announced the existence of the Semi-Automatic Ground Environment, or SAGE, a string of air defense centers that were the earliest variants of modern command and control.

SAGE centers were huge multistory blockhouses built around Whirlwind computers, each of them running on 50,000 vacuum tubes. A battle staff followed the flow of surveillance and warning information on radar scopes and electronic situation maps and scrambled fighter-interceptors as required. SAGE remained in business until 1983, by which time the technology was obsolete and the threat had shifted from bombers to ICBMs.

In 1957, Strategic Air Command moved into its famous underground command post, built to survive anything less than a direct hit by a nuclear weapon. For the duration of the Cold War, SAC was synonymous with command and control in the popular understanding.

The US launched the world's first communications satellite, Project Score, in December 1958. It broadcast a recorded Christmas message from President Dwight D. Eisenhower from space for 13 days before the battery failed.

In 1963, the Defense Department attempted to pull all of its command and control assets together in a sprawling computer-based network called the Worldwide Military Command and Control System, or WWMCCS. The primary mission of WWMCCS was support of the national command authorities, with the needs of all other participants secondary. It never worked smoothly, though, because the component systems, built for individual purposes, were not interoperable. WWMCCS was finally replaced in 1996 by the Global Command and Control System.

FORCE MULTIPLIERS

In the Vietnam War, attention returned to the command and control of general purpose forces. The conflict also marked the peak of analog military communications. AUTODIN, which began in 1968, was the first generation of digital communications.

The Air Force operated several command posts on the ground—notably "Blue Chip" in Saigon—supplemented by Airborne Battlefield Command and Control Center EC-130s and "College Eye" EC-121 radar aircraft, which warned fighters over North Vietnam of approaching MiGs and kept US aircraft from straying across the border into China.

In addition to regular reconnaissance by RF-4s and other aircraft, the Air Force experimented in Vietnam with some

An E-3 AWACS, such as this one, can look out for hundreds of miles, spot enemy aircraft, and direct friendly aircraft to enemy positions.

USAF photo by Val Gempis

Photo courtesy of David A. Deptula

Command and control was seen in a new light after the Gulf War, in which Lt. Col. David Deptula (center)—later USAF's first deputy chief of staff for ISR—was the principal attack planner for the air campaign.

unusual methods. Among these were Buffalo Hunter reconnaissance drones—30 years before the RQ-1 Predator—and 20,000 acoustic and seismic sensors seeded along the Ho Chi Minh Trail and monitored by orbiting EC-121s.

Technology did not yet provide officials in Washington with a full picture of the war but that did not stop President Lyndon B. Johnson from micromanaging the air operation, down to the selection of individual targets.

Elsewhere, the Air Force was putting the finishing touches on the E-3A Airborne Warning and Control System, which would revolutionize air combat. AWACS, operational in 1977, mounted a rotating radar dome on a Boeing 707 airframe.

The radar reached out for more than 250 miles, beyond the curvature of the Earth, to see every airplane in the air. It was also able to pick low fliers out from the hodgepodge of "ground clutter" returns, which previous airborne radars could not do. Operators aboard AWACS could direct the air battle with great effectiveness and economy, establishing the E-3A's value as a force multiplier.

Another innovation, with vast importance in later years, was the Joint Tactical Information Distribution System in the 1970s. It divided every second of time into 128 segments, each allocated to a user for transmission of short data blocks. There were no central nodes to disrupt or destroy.

JTIDS evolved into the Link 16 digital information network, which Gen. Gilmary Michael Hostage III, then commander of Air Combat Command, described as "the backbone of our modern tactical command and control architecture."

FROM THE GULF TO THE CAOC

The Gulf War of 1991 was a major turning point. The last big air action had been in Vietnam, and in the 20 years that had elapsed, the Air Force had not put any great emphasis on the conduct of command and control.

During the Desert Shield preparation phase in 1990, the tactical air command center in Riyadh was initially in an inflatable shelter—the outdated "Rubber Duck," familiar from Vietnam days—set up in a parking lot until space was made for it indoors.

Even so, the bumper crop of modern technologies gave the coalition an unbeatable edge. Desert Storm is sometimes described as "the first information war" or "the first space war." Imagery, intercepts, and linkages from all kinds of aircraft and satellites were in daily use. The E-8 JSTARS, which tracked enemy forces moving on the ground as AWACS did with forces in the air, was rushed into action while it was still under development.

The Iraqi command and control network was struck in the opening night of Desert Storm. By sunrise, it no longer existed, wiping out Iraq's capability to mount a coherent military response.

The principal attack planner for the Desert Storm air campaign was Lt. Col. David A. Deptula, who 15 years later would become the Air Force's first deputy chief of staff for intelligence, surveillance, and reconnaissance.

The Gulf War demonstrated the critical importance of command and control, and Air Force leaders were quick to respond. Air operations in Bosnia in 1995 were effectively directed from a combined air operations center. One of the sensors feeding in battlefield information was the new MQ-1 Predator unmanned aerial vehicle.

For the air campaign in Kosovo in 1999, the CAOC had more than tripled in size and was the nerve center of the operation. "Streaming video," live from Predator, allowed rapid targeting and retargeting. Gen. John P. Jumper, commander of US Air Forces in Europe and a future Chief of Staff, declared that the CAOC had become a weapon system in its own right.

Confirming Jumper's judgment, the AN/USQ-163 Falconer Air and Space Operations Center was established as the standard command post configuration. Falconer CAOCs now support commanders in various theaters. In 2003, the big CAOC for the Middle East moved from Prince Sultan Air Base in Saudi Arabia to Al Udeid Air Base in Qatar.

REACHBACK/FORWARD

By the late 1990s, digital data links made the procedure known as "reachback" possible. Information going into the CAOC could just as easily be sent to the United States. Operators half a world away could refine and analyze the data and have targeting information on its way back to the theater in 30 minutes. This meant that hundreds of people no longer had to deploy forward. Their tasks could be done as well, if not better, from ISR centers at home.

In 2002, the Air Force adopted a concept of "remote split operations" in which Predators were launched and recovered by crews at forward locations but flown on their missions by pilots in the United States using satellite links. Shortly thereafter, the Distributed Ground System created online "chat rooms" with ISR analysts in the United States joined in a control loop with the CAOC and others in the theater.

Reachback lost some of its credibility in 2001 when Army Gen. Tommy A. Franks of US Central Command decided to run Operation Enduring Freedom from his headquarters in Tampa, Fla., rather than relocate to the theater, as Gen. H. Norman Schwarzkopf Jr. did in Desert Storm.

The Combined Air and Space Operations Center at al Udeid AB, Qatar, provides command and control of airpower throughout Iraq, Syria, Afghanistan, and other countries in the region.

The CENTCOM staff watched live video links from Predator and individual strike aircraft and made decisions about targeting and other matters eight time zones away. In one instance, the legal officer persuaded Franks to veto a target on the grounds that it might be a trick to sucker in a strike that might have legal ramifications. As a result, an important convoy was not struck.

Conversely, CENTCOM intelligence, demanding "total certainty" of attack results, forced the re-attack of targets that were already destroyed.

The benefits of a strong in-theater CAOC augmented by reachback were obvious, but Air Force leaders felt a need to adjust the balance with renewed emphasis on the principle of centralized control-decentralized execution. It was important to leave battle area decisions, where possible, to those closest to the action.

"We need discipline to ensure that 'reachback' does not become 'reach-forward,'" said Deptula, who retired in 2010 as a lieutenant general and is now dean of the Air Force Association's Mitchell Institute for Aerospace Studies.

The traditional terminology is misleading. "Centralized *control* should be centralized *planning,*" Deptula said. "It's not control. You've got to have a coherent plan that's focused on the end game. You also have to enable those who are executing it, who have the greatest degree of situational awareness, to act within the guidance to capitalize on the immediacy of what's going on to support the overarching objective."

In an article for *Air & Space Power Journal,* Deptula said, "Information synthesis and execution authority must be shifted to the lowest possible levels, and senior commanders and their staffs must discipline themselves to stay at the appropriate level of war."

INTO THE CLOUD

Former Air Force Secretary Michael W. Wynne believes that large C2 and ISR platforms like AWACS and JSTARS will be too vulnerable to survive in future conflicts and their functions should be redistributed. Stealthy aircraft like the F-22 and the F-35 can and should take on more of the ISR role, he says.

Deptula agrees but predicts that "it's going to happen over a longer period of time than either Mike Wynne or I would like."

"The era of specialized aircraft is over, as technology has moved on and resource constraints have grown," Deptula says. Modern airplanes should be thought of as sensor-shooters, he says. "Every aircraft should have a sensor function," he says. "Most of them will have a shooter function. They should be viewed as nodes in an integrated ISR-strike-maneuver-sustainment complex where the underlying operative is the ability to ubiquitously and seamlessly share information."

The way to achieve this integration is the "combat cloud," of which Deptula is the leading advocate. "The combat cloud concept is somewhat analogous to 'cloud computing,' which is based on using a network (e.g., the Internet) to share information rapidly across a highly distributed, self-evolving, and self-compensating network of networks," he says.

"However, instead of combining the computing power of multiple servers, the combat cloud combines the war-fighting power of combat systems by capitalizing on C2 and ISR networks to quickly exchange data derived from any source across an all-domain architecture of sensors and shooters to increase their effectiveness and attain economies of scale."

Command and control continues to grow. In recent years, USAF force structure has declined but its ISR assets have almost tripled.

Between 2001 and 2015 the number of ISR missions launched per day has increased by an incredible 2,300 percent. Most of that has been by remotely piloted aircraft that can loiter over targets for an entire day.

One of the more recent developments is "Gorgon Stare," a wide-area capability on long-endurance MQ-9 Reaper RPAs. Instead of the narrow view provided by Predator, Gorgon Stare imagery takes in a swath of 64 square miles.

In 2014, the Air Force ISR Agency was upgraded to 25th Air Force under Air Combat Command. It is billed as "the one-stop shop for operational ISR within the Air Force," also responsible for electronic warfare and airborne national command and control.

"During the Desert Storm air campaign, aircrews were assigned the vast majority of targets to be attacked before they took off," Deptula said in 2014. "Today, over Afghanistan, the vast majority of such targets are not specified to the aircrews delivering the effects—and often remain unknown to planners—until well after the sensor-shooter aircraft are airborne."

"Network-centric, interdependent, and functionallyintegrated operations—perform by the right mix of available forces, regardless of service, are the keys to future success in war fighting." ✪

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