Chapter Four: Command, Control, Communications, Computers, And Battle Management

Any discussion of the Gulf War that seeks to derive lessons about command, control, communications, computers, and battle management (C^4/BM) must be prefaced with several important caveats. The choice of what to analyze, and how to analyze it, is not a simple one. The Gulf War was one of the most complex conflicts in history, and involved major innovations in command and control.[1]

- First, the question arises of "lessons for whom?" The Gulf War was fought between a UN Coalition and Iraq, but the UN did not exercise practical command from either UN headquarters or from the field. The US was not simply prima inter pares, it exercised de facto command over most of the planning before the war, controlled the way in which the war was fought, and made the most of the key decisions regarding conflict termination. While there was a joint command in the field, the US led this command in close cooperation with Saudi, British and French commanders. While Egypt, Kuwait, Syria and the other members of the Coalition made national decisions about the role of their forces, they did not play a major role in the overall command system. As a result, command, control, communications, computers, and battle management (C^4/BM) during the Gulf War is not representative of a war where the UN exercised direct command, or a multinational command existed in which several nations had to play an equal role.
- Second, the US had a near monopoly of sophisticated national intelligence systems, electronic warfare, targeting, command and control, and space systems. The US deployed and exercised sole control over a wide range of theater command and control systems such as the JSTARS, and the US and Saudi Arabia deployed and operated other key command and control systems like the ground-based sensor net, the Airborne Warning and Air Control System (AWACS), the central ground communications system, and the mix of sensors and communications used to control air defense and air attack operations. This technological asymmetry is likely to be repeated in future conflicts between the US and Third World states, and the lessons that stem from it have important implications for the future. At the same time, it makes the command and control lessons that apply to the US different from those that apply to most other members of the UN Coalition, and also different from

Copyright Anthony H. Cordesman, all rights reserved

those that would apply to any coalition in which the US did not deploy such systems.

- o Third, most of the other nations that fought in the Gulf War have published comparatively little on their command, control, communications, computers/battle management experiences (C^4/BM) during the war, and much of what has been published on their C^4/BM activities consists of anecdotal memoirs. Iraq has published little on its experiences and lessons, and presents a special problem because it is impossible to trace the true nature of many command and control systems and decisions -- exerted by Saddam Hussein and his immediate coterie outside the formal Iraqi chain of command.
- o Fourth, the analysis of command, control, communications, computers, and battle management (C^4/BM) cannot be fully decoupled from the personal impact of key decision makers and their personalities. As many histories and memoirs have already made clear, command and control during the Gulf War was shaped by key commanders in ways that had little to do with the particular command and control systems, communications, and related technologies employ in the war. The human element does not lend itself to simple judgments about the lessons of war, but it is a dominant element at every level of command and control.
- o Fifth, there is the problem of goals and standards of comparison. The Gulf War represents the most successful effort to date to integrate command and control, communications, battle management, reconnaissance, intelligence, targeting, and battle damage assessment (C^4/BM/RIT/BDA) into a unified and near real-time effort. At the same time, there were many problems in this effort because the US had only begun to the transition from a focus on East-West conflicts to one on regional conflicts.

  o Sixth, many key US command and control systems and technologies for the AirLand battle were not yet deployable, or were in a state of transition. Although computers were deployed throughout US and UN forces, the computational capability, software, and interconnectivity or "netting" was often primitive by the standards coming into service. One of the lessons that many experts drew from the war is that command, control, and communications (C^3) should be changed to command, control, communications, and computers (C^4). This is a useful lesson, but it clearly implies that the operations, hardware, and capabilities of the future will be different from those of the Gulf War.

  o Finally, there is also the issue of whether standards of comparison should be relative or absolute. The UN and the US had to improvise virtually every aspect of

Copyright Anthony H. Cordesman, all rights reserved

its C^4/ BM/RIT/BDA system over the five and one-half months before Desert Storm. This period of preparation can scarcely be counted on in the future, and there were still serious failures and inadequacies in spite of the time available during Desert Shield. If the US and Coalition C^4/BM/RIT/BDA systems are judged by Iraqi standards, they were vastly superior. If they are judged by the standard of victory, they were obviously successful. If, however, they are judged by the standard of "perfect war," they were often failures. It is difficult to determine whether lessons should be drawn on the basis of whether a given system was employed as effectively as possible, or exhibited significant limitations.

This analysis approaches these issues by focusing on the US experience in command and control, with the understanding that this focus understates the lessons of the war for other members of the Coalition and Iraq. It deals with systems and technology largely in terms of US systems and technology, again knowing that such an approach is inadequate, and disguises important lessons about the war in terms of the capabilities and needs of Third World forces. It deliberately avoids the issue of the impact of key command personalities on the conduct of the war -- not because this impact was not of critical importance, but because it involves uncertainties and value judgments that seem unlikely to produce broad lessons for future conflicts.

The analysis of C^4/BM/RIT/BDA is also divided so it can be linked to key aspects of war fighting. This chapter provides an overview of key lessons and issues relating to C^4/BM. The following chapter deals with intelligence. The chapters on air, AirLand, naval, and other specialized aspects of combat operations contain sections on the more specialized aspects of "C^{4I}/BM/RIT/BDA".

The Need for Joint Central Command and Specialized US Support: Coalition Command, Control, Communications, And Intelligence (C^4I) Systems

The joint command structure of Coalition forces is shown in Figure 4.1. While this table is comparatively simple, it disguises the fact that the political and military efforts to create these command relationships were a key aspect of the diplomacy of the Gulf War, and that such a command structure would never have been workable if there had really been four equal commanders linked only by a process of coordination.

The Lesson of Joint Saudi-US Command

In practice, the Coalition Command structure built upon the joint Saudi-US command structure, created in the National Defense Operations Center of the Saudi Ministry of Defense and Aviation (MODA), which began operations on August 23, 1990.[2]

Copyright Anthony H. Cordesman, all rights reserved

A combined operations center or "C3IC" was established that brought together the Saudi high command with USCENTCOM headquarters, the USCINCENT war room, the USCENTCOM joint operations center, the USCENTCOM Joint Intelligence Center and representatives of the Saudi National Guard.[3] This C3IC was jointly directed by the Vice Deputy Commanding General of the US Army Central Command (ARCENT) and the Saudi Joint Forces Commander. It had ground, air, naval, special operations, logistics, and intelligence sections jointly manned by Saudi and US officers. There were liaison officers from Britain, Canada, the French Force Daguet, the Saudi Arabian National Guard, and VII Corps.

The creation of the C3IC minimized the impact of preserving separate national chains of command because one point of coordination handled the coordination for both Western and Arab forces, as well as day-to-day decisions like the coordination of planning, training activities and areas, firing exercises, logistics, and radio frequency management. It also centralized most aspects of intelligence and reconnaissance planning, assessment, dissemination, the coordination of boundary changes, and fire support coordination during Desert Storm.[4]

This type of joint -- but parallel -- command may have important implications for future coalition warfare. It helped reduce the potential for misunderstanding between nations with very different military cultures, and ensured close coordination. It avoided creating a situation where the host country might find itself subordinated to a coalition or foreign national command because that command had superior technology, communications, and experience. It reduced the tendency to generate competing plans that affected Anglo-American command efforts in World War II, and helped develop a common day-to-day picture of the military situation. This success was reinforced by the fact that the daily situation briefing was prepared by both Saudi and US officers, who alternated in giving the daily brief.

Copyright Anthony H. Cordesman, all rights reserved

Figure 4.1

Command Structure for UN Coalition Forces in the Gulf War

Source: Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, Annex K, p. K-22.

Copyright Anthony H. Cordesman, all rights reserved

Drawing On Specialized US Command Expertise

Like most aspects of Coalition activity in Desert Storm, developing an adequate C4I/BM system took months of effort. Creating this new command structure required a radical shift in the staff activity within the Saudi MODA, which had never been organized or trained for a high intensity war. It also required vast improvisation by the US. Although power projection to the Gulf had been a major planning priority since the late 1970s, the US lacked plans, organization, equipment, and training to deploy an effective C4I/BM without months of crash effort and improvisation.

The US began by drawing on the command structure the it had created within the US Central Command (USCENTCOM) headquarters at MacDill Air Force base in Florida, as well as within the various service elements within this command.[5] The Army component of USCENTCOM -- ARCENT -- drew on a peacetime headquarters staff at Fort McPherson, Georgia, under the Commander of the 3rd Army. It drew on elements of other commands, including FORSCOM. It began to arrive in theater as early as August 8, and had reached 266 personnel by August 23. This command was reinforced to the point where it took over responsibility for much of the planning of Coalition logistics and support activity, as well as most of the specialized joint war planning activity.[6] The Air Force Component -- CENTAF -- was headquartered at Shaw Air Force Base, South Carolina, under the commander of the 9th Air Force. Deployment of this command took place during August 6 to 26, and then built-up steadily over the months that followed. Like ARCENT, CENTAF provided most of the specialized staff for the entire Coalition command.[7]

The Navy component (NAVCENT) was not placed under the commander of the US Middle East Task Force, but rather under the Commander of the US 7th Fleet, who deployed into the area by air on August 15, 1990. The Navy used staff from its peacetime headquarters at Pearl Harbor, Hawaii, and was based at first on the command ship *La Salle* and then on the 7th Fleet flagship, the *Blue Ridge*. This proved to be a problem as time went on, since the senior Navy commander was located so far from Riyadh, and the senior Navy officer located at the Coalition command lacked the rank and status of his counterparts.[8]

The commanding general of the 1 (US) MEF who was also the commander of the Marine component -- MARCENT. Its headquarters was located at Camp Pendelton, California. He deployed to the US Marine units in Eastern Saudi Arabia, but sent a deputy to Riyadh. The Marine command in the field initially played a major role in coordinating the Arab, British, and US Army light forces in Desert Shield. In the process, it became apparent that the USMC was not set up to fully staff and equip a commander with joint functions. Personnel from the US Army and USAF were provided as liaison to 1 (US)

Copyright Anthony H. Cordesman, all rights reserved

MEF) to ensure suitable coordination, and the Army and Air Force had to provide added communications equipment when the Marine Corps communications system proved inadequate, and lacking full interoperability with that of the other services. As time went on, additional Marine command elements had to be co-located with NAVCENT to provide amphibious planning and coordination. Even so, some coordination problems continued between the MARCENT headquarters and the amphibious planners and US commanders.[9]

The US Special Operations component -- SOCCENT -- began deployment in early August, and drew on staffs normally headquartered at MacDill Air Force base in Florida. It relocated to King Fahd Airport in mid-August, and established a forward headquarters at King Khalid Military City, and a search and rescue component at Ar'Ar. Elements of the SOCCENT forces were subordinated directly to other commanders. These include SEAL units under the command of NAVCENT, AC-130 gunship and EC-130 Volant Solo units under the operational command of MARCENT and AFCENT, A coordinating element of British special forces was set up at SOCCENT headquarters. It is unclear whether all the special forces units of other countries coordinated fully with SOCCENT, but British, Egyptian, French, and Saudi liaison seem to have been present.[10].

The initial manning and structure of these USCENTCOM, ARCENT, AFCENT, NAVCENT, and SOCCENT commands were, at best, adequate for low intensity war. No aspect of their pre-Gulf War structure and capacity proved adequate to meet the demands of large scale theater warfare. All had to be steadily expanded and restructured with each major increase in US and allied forces, as the Coalition shifted from defensive to offensive operations. Massive transfers of hardware and functions had to take place from other headquarters, and key aspects of communications systems and connectivity had to be adapted to new roles and expanded in capacity. The Navy and Marine Corps experienced additional problems because they were less prepared for large scale joint operations.

Fortunately, the problems that the US faced in restructuring and expanding its C^4I/BM system were reduced by the level of cooperation that the US received from other states. It would have been impossible to execute Desert Storm with anything approaching its actual effectiveness without the creation of a joint Saudi-US C3IC command structure discussed earlier, or the willingness of other nations to effectively subordinate many of their planning and operational activities to the C3IC on a day-to-day basis, and without the ability to make extensive use of US headquarters, planning, and specialized staff elements.[11]

While national contingents remained under national command, it would have been impossible to fight anything approaching a coordinated AirLand battle without the resulting combination of centralized staff functions, and the specialized expertise provided by the US

Copyright Anthony H. Cordesman, all rights reserved

services. For example, it would have been very difficult to achieve effective coordination between Western and Arab forces if Saudi Arabia had not allowed the US to set up component commands near Riyadh, if the US and Saudi commanders had not co-located and created an integrated staff, if Saudi command over all Arab forces had not meant that the commanders of other Arab nations were co-located with Western forces, if Britain had not integrated its command structure under the US command, and if France had not collocated key personnel in the Coalition headquarters and placed its forces under the tactical control of the ARCENT commanders in charge of XVIII Corps operations in mid-December.

Lessons For High Command.

At the same time, the ability of the UN Coalition members to agree on the C3IC , and to create a functioning C^4I/BM system, is only one aspect of command in warfare. The human dimension of high command was at least as important. Any review of the memoirs of the senior commanders of UN Coalition forces reveals many areas of friction on a national and personal level, in spite of the creation of a C3IC. It is easy to focus on this friction, and choose sides between nationalities, individual commands, and personalities. If Coalition commanders are judged by historical standards, however, the frictions between them were remarkably minor, particularly given the differences in country, culture and the fact that the US was not only employing a new concept of warfare for the first time, but was asking other nations to adapt to that concept of warfare.[12]

Several factors played a key role in the ability of senior commanders to work effectively and cooperate, which may serve as lessons for the future:

- *Political leaders delegated military command functions, and rarely micromanaged:* Military commanders could not have cooperated as effectively if political leaders had attempted to interfere in the details of command, cooperation, military planning, and battle management. It is a tribute to both the political and military leaders of the Coalition that the proper balance of political and military authority was preserved by so many countries.
- *Effective joint command:* De facto unity of command under a US and Saudi commander -- with all major functions collocated in one allied headquarters with a joint Saudi-US staff -- helped to ensure effective joint command of the activity of each nation and military service, and was essential to ensuring that national contingents could fight in coordination with US concepts of joint warfare and the AirLand battle. This joint command was reinforced by the fact one US military service -- the USAF -- exercised a critical role in providing unified command over many aspects of air operations, and by the fact that the air campaign could be

Copyright Anthony H. Cordesman, all rights reserved

conducted separately from the AirLand battle, which only took place once the air campaign had achieved a decisive victory. This reduced potential command conflicts over how to allocate different military resources and combat arms, and the risk that a given national command would suddenly encounter sufficient trouble to create a crisis over the allocation of coalition resources. The need for effective joint command and delegation of command is as important a lesson as the need for effective unity of command. Whether it can always be achieved is another issue.

- *Military leaders were trained and willing to cooperate, and most of the forces in the Coalition had prior training or experience in cooperation:* Senior commanders invariably operate under great pressure in war time, and military history is always the history of personalities acting out under extreme stress. The Gulf War had its share of personal clashes and incidents. At the same time, commanders showed an unusual understanding of the realities of coalition warfare, avoided open conflicts and rivalries, and actively sought to cooperate at virtually every level. This was partly a matter of personality, but it was also a matter of experience. Unlike the national commanders of many previous coalitions, senior commanders were used to cooperating with other nations and most had extensive personal experience and training in joint commands, exercises, or planning. The close military relationships between the US and Britain, Saudi Arabia, France, and Egypt played a major role in easing the strains of command and cooperation. This cooperation was enhanced by joint exercises and training, the reliance of Saudi Arabia on Western arms and advisors, and the creation of a generation of commanders who had cooperated in NATO and in joint exercises in power projection.
- *The US was tacitly given unity of command in key areas of planning, coordination, and operations:* None of the Coalition nations gave up sovereign control over their military forces. At the same time, all of the southern Gulf countries had agreed to provide access to US forces by August 16, and USCENTCOM had set up a joint headquarters in the Saudi Ministry of Defense by mid-August. Saudi Arabia, Britain, France, Egypt, and Kuwait gave the US extraordinary freedom in managing the overall command structure, military planning, and battle management. While each of these countries, and other nations like Syria, asserted national prerogatives in shaping strategy, the role of their forces, and some aspects of battle management, any historical comparisons with World War I and World War II indicate that the Coalition fought with extraordinary unity.
- *Ideas, innovation, and action:* In theory, high command should make developing and implementing innovative new approaches to war a key priority. In practice, it

Copyright Anthony H. Cordesman, all rights reserved

often becomes remarkably rigid, or paralyzes action with internal debate. Senior Coalition commanders placed an exceptional emphasis on ideas and action had its share of strong and contentious personalities, and national differences. At the same time, debates between commanders were usually quickly and openly resolved. There were significant frictions between national commanders, service commanders, and different echelons of command, but the kinds of personal tension or debates that often seemed to be a fault in the smooth process of military diplomacy were actually vital to ensuring that ideas would be acted upon. There is an important lesson here that is easy to ignore: Command conflict is not desirable, but command tension can be vital to the effective generation of ideas, innovation, and action. So is open debate, and rapid and decisive resolution of that debate once it occurs. Polite command may be soothing, but it is not effective.

- *Command could take advantage of time and a lack of resource constraints:* Once again, the UN was given five critical months in which to set up a coalition command structure, adjust deployments and national roles and missions, and reach agreement at both the political and military level. The US was able to take advantage of a specialized regional command in the form of USCENTCOM, which it had created in 1983, after several decades of close cooperation with Saudi Arabia.[13] The Coalition as a whole was able to take advantage of the British and French experience in Saudi Arabia and large-scale basing and infrastructure facilities that reduced many of the usual national tensions over resources. The value of time, however, is scarcely a lesson of war, since it is impossible to guarantee. What this experience demonstrates is the need to create an effective C^4I/BM system in peacetime, and to train for coalition warfare and major regional conflicts before a crisis begins.
- *A clear mission and objective:* As the previous chapter has shown, it took some time for the Coalition partners to agree on the deployment of major forces, and take the offensive to liberate Kuwait. One major Coalition partner -- Syria -- never reached full agreement as to the objective and mission of US forces. In broad terms, however, Iraq's invasion of Kuwait and threat to Saudi Arabia clearly defined the mission and objective, and created a unique degree of political consensus. As Somalia and Bosnia have shown, the lesson is that few contingencies creating the risk of a major regional conflict are likely to involve a similar consensus, and that most coalition command activity will lack a similar degree of unity.
- *A relatively apolitical battlefield:* Iraq's blatant aggression, and treatment of Kuwait after the invasion,, and possession of weapons of mass destruction and use of long

Copyright Anthony H. Cordesman, all rights reserved

range missiles on civilian targets, gave Coalition commanders considerable freedom of action in shaping the strategic bombing and interdiction aspects of the air campaign, the depth of the battlefield, and the intensity of operations. The fact that most of Iraq's forces were deployed in the open desert or in Kuwait, and that the UN air component was able to use so many smart weapons, also reduced the political problems created by collateral damage and the loss of civilian life, inevitable in urban and guerrilla warfare. The deliberate manipulation of report on the battle to avoid reporting on Iraqi casualties also limited political complications. While the Coalition and US command has since been criticized for its use of force and manipulation of reporting on the battle, the fact remains that these are vital to successful operations in a major regional contingency and to the effective use of force in a highly complex global environment. The need to give commanders maximum freedom of action in using military force is a key lesson of the Gulf War.

- *Functional deployment and subordination of national forces:* As Chapters Two and Three have shown, command problems were reduced by creating clear roles and missions for each of the major national contingents, and deploying them accordingly. The split between Western and Arab forces, placing Arab forces under Saudi command, and giving the Arab forces a supporting role that they could clearly execute in comparative isolation from Western forces played an important role in command and control. So did the fact that this command and deployment structure minimized the impact of Syria's political differences with the rest of the Coalition, and its decision to only commit its combat forces in the supporting role. Similarly, the deployment of French forces to the West, and the decision to resubordinate the British land forces to the major armored thrust, simplified the command and control problem within the Western forces, while central air defense management through the E-3A, and central attack mission planning by the USAF -- coupled to allocating clearly defined mission roles to allied air forces, further reducing these problems.
- *Central control of the media:* While it was not popular with the media at the time and is scarcely likely to popular in the future, the ability to limit media access to the region, and to centralize control of briefings and information, greatly reduced the kind of reporting on command frictions and national issues that can complicate the practical implementation of coalition warfare. There is no practical way to resolve the inherent conflict between freedom of information and effective military action, and between the different needs of the media and the military in protecting a free society. In broad terms, however, effective control of the media is critical to effective command, as well as to secrecy and increasing freedom of action, and the

Copyright Anthony H. Cordesman, all rights reserved

recognition of this fact -- and an emphasis on giving the media full access to information after a campaign as a control on any abuse of military capability -- is one of the lessons of the Gulf conflict.

The most critical of these lessons is the need to develop combat ready C^4/BM capabilities for major regional contingencies in peacetime. Only Iraq's passiveness allowed the US to develop an adequate C^4I/BM system during Desert Shield. US peacetime planning before the Gulf War produced the illusion of capability without the reality, and the US was often forced into deploying vast amounts of C^4I/BM personnel and equipment to compensate for an adequate architecture and method of properly allocating resources and delegating functions. The US required months to create its own internal structure for managing the air campaign and the AirLand battle, that the US should have spent years refining its C^4I/BM capabilities before Desert Storm. Even then, the structure that the US was able to improvise had many avoidable weaknesses.

It is easy to bog down in debates over whether the US improvised the right command structure at any given level during Desert Shield. Such debates, however, are of minor importance compared to the fact that the US should not have had to improvise such capabilities at all. The Gulf War is a lesson that the US needs to organize its C^4I/BM structure to be fully ready for large scale regional conflicts in peacetime, to tailor its system to support coalition warfare, to discuss detailed wartime contingency arrangements with major regional allies like South Korea and Saudi Arabia, and to subject the resulting system to the most demanding possible exercise tests. Effective power projection capability requires rapidly deployable C^4I/BM capability for high intensity warfare.

High Technology Central Air Battle Management: C^4I/BM in the Air War

The value of central control of air war is another important lesson of the Gulf War. While the formal organization of Coalition forces shown in Figure 4.1 reflects divisions between national -- and Arab and Western -- forces, the reality was that the US exercised control of air warfare planning and operations and related command, control, communications, computers, and intelligence capabilities. It also managed most AirLand communications, weather analysis, and the provision of navigation data.[14] This centralized command of the air operation has important implications for command and control in future conflicts. It also helped to create a centralized and integrated command system cable of unified AirLand operations. The success of many aspects of such centralized battle management sets an important precedent for both multinational and multi-service force coordination.

Copyright Anthony H. Cordesman, all rights reserved

The Role of the Joint Forces Air Command (JFACC)

One key to this success was the appointment of a single joint commander. On August 10, 1990, Lt. General Charles A. Horner, the Commander of US Central Command Air Forces (CENTAF) was designated as the Joint Forces Air Commander (JFACC). This was an important step for several reasons. It created a central command point that grew to provide C4I/BM for virtually every aspect of planning the build-up of UN air forces during Desert Shield, planning the air war, commanding allied forces as well as all US services, integrating the C4I/BM systems of different forces, and managing daily air operations during Desert Storm.

This system was an innovation in terms of US command systems, as well as in large-scale coalition warfare. Desert Storm was the first regional contingency in American military history where a single commander was designated as the commander of all joint and multi-national air operations, and given responsibility for planning the air campaign, and coordinating, allocating, and tasking apportioned Coalition air sorties to meet the theater objectives.[15] This took on special importance because air power played so dominant a role during most of the war, and because General Schwarzkopf did not attempt a day-to-day management of the air war. Schwarzkopf did make important decisions about apportioning resources, the weight of air effort in support of the land battle, and the priority of attacks on Iraqi military forces over strategic bombing, but it was the JFACC that allocated and tasked a force of over 2,700 fixed wing military aircraft, 25% of which were non-US aircraft, and which were normally commanded by 14 different countries or services.

Making the JFACC effective, however, was anything but easy. It meant creating a doctrine and plan for theater air war that could compensate for the prewar failure to develop an effective theater air war C4I/BM system.[16] It also meant developing a joint command that included Saudi Arabia, with the problem of planning the many details of moving US aircraft into Saudi Arabia. In practice, US and Saudi cooperation quickly reached the point of joint planning, with the JFACC doing most of the detailed planning for air defense. Nevertheless, the JFACC was able to issue the first major operations order for the defense of Saudi Arabia (Operations Order 003) on August 20, 1990.[17]

The key to the multinational success of the JFACC was close US and Saudi cooperation. This cooperation was enhanced by the fact that General Horner had worked closely with the Saudi Chief of Staff, General Mohammed al-Hammad, and the Commander of the Saudi Air Force, Lt. General Ahmad Ibrahim Behery, before the war, and received cooperation from both General Khalid and Brigadier General Ahamid bin Musaid As-Sudayri, the Chief of Operations of the RSAF. This cooperation broadened as

Copyright Anthony H. Cordesman, all rights reserved

the JFACC came to coordinate planning for the employment of the RAF and French Air Force. The JFACC defined basic operational rules like air-to-air and air-to-ground rules of engagement, and coordinated these within the alliance in mid-August, although many aspects of tactics and force allocation remained a national responsibility.[18]

The Tactical Air Control Centers (TACC)

The JFACC was supported by the Tactical Air Control Center or TACC, which provided the central command center for the JFACC, coordination of key data and communications, and near real time planning and overall battle management. The TACC acted as the fusion center for the complex mix of US and Saudi airborne command and control and sensor platforms used in the air war. It allowed the JFACC to control aircraft in the Kuwaiti Theater of Operations (KTO) to ensure a minimum risk of mid-air collision, identify and track Iraqi aircraft activity, retask aircraft enroute, provide central review of airborne control of where strike aircraft and tanker aircraft met for refueling.

The fact that some of these capabilities were functioning in theater by September is a considerable tribute to the US personnel involved and to the support they received from the RSAF. Additional ABCCC assets deployed on August 26, to support the TACC, although they had limited combat capability until September 20. The basic system, which allowed the TACC to use a wide range of AWACS orbits during the rest of Desert Shield and during Desert Storm -- based in part on Saudi experience -- was only tested by late October. The addition of the JSTARS was a last minute decision: The two developmental J-8 JSTARS aircraft deployed on January 11, 1991.[19]

The deployment of effective communications for the TACC and related air units lagged badly behind schedule, and this is another a warning of the need for better peacetime preparation for future conflicts. The basic TACC communications architecture could not be tested until late October, and communications capabilities had to be layered and made redundant because no pre-war planning had prepared a usable plan or architecture.[20] The TACC also encountered important technical problems -- including a lack of interactive software -- because the US had never really planned and tested the control and communications systems needed for such an intense and high tempo air war before Desert Storm.

An immense volume of air communications activity took during the air war. While specific data are not available for the TACC, CENTAF logged a total of 1,293,775 incoming messages, 132,012 out going messages, and 29,542,121 phone calls during the Gulf War. Only 135 of the required 1,128 USAF communicators were in theater by late August, and a total of 2,300 communicators were eventually deployed. The secure phone system still had serious problems in late September, and a total of 350 STU-III phones were

Copyright Anthony H. Cordesman, all rights reserved

eventually required. Switching and message allocation had serious problems. Moderate satellite link capability had to be rapidly brought in, and was not fully deployed until late November. By the time this build-up was complete, CENTAF had 36 telephone switches, 26 ground mobile force terminals, 39 tropospheric radio links, three ground-to-air transmitter/receiver sites, 55 computer assisted force management system terminals, and was dealing with 7,665 frequencies.[21]

Although the resulting system became highly complex, it is important to note that the resulting "fusion" of communications and sensor data was only a fraction of the potential capability for "information warfare" that many planner now seek for future wars. This makes it even more important to deploy and test a full scale battle management system in peacetime, and to keep it ready for major regional conflicts without extended periods of warning.[22]

The Special Planning Group or "Black Hole"

There were many other activities and systems that were essential to the US-led "fusion" of different Coalition air warfare, AirLand battle, and C4I activities. One was of particular importance. Lt. General Charles A. Horner, the commander of CENTAF, created a secret Special Planning Group under Brigadier General Buster C. Glosson.[23] This Special Planning Group, which came to be called the "Black Hole", was charged with the creation of the offensive air war plan. This group was located in the Saudi Air Force Headquarters. It included RAF and RSAF officers, and eventually became both the planner and central manager of the air war, coordinating targeting intelligence as well as strike planning.[24]

This activity became even more important as the original AirLand battle management concept expanded and as a strategic bombing effort was combined with a massive theater-wide effort to attack Iraqi military forces. Throughout Desert Shield and the actual air campaign, constant adjustments had to be made the scale of the offensive air effort, the relative emphasis given to strategic and theater targets, the weight of effort given to attacking given sets of targets, and the tactics involved.[25]

Considerable tension sometimes developed over how much weight should be given to strategic and Iraqi military targets. There were some air planners that believed strategic bombing could be decisive. As is discussed in Chapter Seven, this focus on strategic bombing effort had its origins in a plan called "Instant Thunder." This plan was proposed in early August by a team led by which Col. John A. Warden III, and was the first attempt at an offensive air plan in response to the Iraqi invasion. It called for a massive sudden and precise air attack on key Iraqi political, industrial, economic, social, and military institutions.[26] As is discussed in Chapter Seven, however, the initial draft failed to address the need to defeat Iraqi ground forces and tactical air forces and CENTAF soon focused on

Copyright Anthony H. Cordesman, all rights reserved

its on planning effort which emphasized destruction of the Iraqi ground forces as well as strategic bombing.[27]

The creation of a Special Planning Group did not prevent some air planners from emphasizing strategic bombing and the role of air power, or solve the problems inherent in interservice and Coalition coordination. It did, however, create a mechanism through which the resulting debates over the allocation of air power could be resolved in the creation of one integrated air battle plan. It provided a command and planning mechanism for a more comprehensive approach to offensive air war, and the Special Planning Group came to combine planning for both the strategic and tactical air campaign.

As the Coalition moved towards the start of Desert Storm, the Special Planning Group was also combined with the Combat Plans Division of CENTAF to form the Campaign Plans Division. This reorganization took place on December 17, 1990 and gave the "Black Hole" a more orthodox position in the chain of command. It scarcely solved all the problems created by central management of the offensive air campaign, but it did allow central control to work more effectively.

Like the JFACC, the Special Planning Group and Campaign Plans Division acquired a great deal of central authority and autonomy. Like the JFACC, they have sometimes been criticized for these qualities and for bypassing the normal chain of command. The Special Planning Group has also been criticized for creating a duplicate staff to many CENTAF functions, for compartmentalizing the planning process to the point where proper coordination did not occur, for bypassing the normal intelligence and targeting process, and for creating a new targeting process that degraded the quality of targeting data provided to air units.

Some of these criticisms seem legitimate, and some are recognized as such by those who participated in the SPG. At the same time, the US simply had not prepared realistically to fight a major theater level air campaign before Desert Storm, and no improvised central staff could deal effectively with all of the resulting problems in the time available. A lack of pre-war contingency planning virtually ensured that some body like the Special Planning Group had to perform a "forcing function" under conditions that made problems and friction inevitable.

More broadly, it is far from clear that less centralization, a more orthodox approach to bureaucracy, and more sensitivity to peacetime lines of authority would have been as effective. The Special Planning Group provided a centralized and cohesive offensive war plan, and a staff to refine and execute it, at a time when CENTAF and the JFACC were focused on creating an effective air defense as part of Desert Shield. It overcame delays and problems in the intelligence process that might otherwise have not been corrected. It

Copyright Anthony H. Cordesman, all rights reserved

provided a staff that was secure enough to plan the effective use of sensitive systems like the F-117 Stealth fighter, and it forced the systematic resolution of a number of turf battles.[28] The benefits of more open coordination and planning might have been counterbalanced by encouraging the kind of debates between Coalition air forces and military services that affected virtually every aspect of war planning in World War II.

The challenge for future wars is to find a way to preserve the benefits of a centralized battle management staff while making its operations more open, and finding ways to create a better balanced between the priorities of air and land commanders. One solution may be to include a larger ground component, and to use such a staffs as a test bed in peacetime exercises to determine how to be define its role and integrate it into control and communications and intelligence systems. The problems discussed in Chapter Seven indicate, however, an effort at effective air battle management requires a clearer understanding of the relative effectiveness of strategic and theater air campaigns, and central management of tactical air operations versus responsiveness to ground commanders. Many of the problems in air command and control and battle management stemmed far more from a lack of comprehensive air warfare doctrine, integrated into the overall need to find an AirLand battle, than from the way C4I/BM was organized during the Gulf War.

The Master Attack Plan (MAP).

The US used two key management tools to provide centralized command and control, and battle management, of most aspects of the offensive air war. These were the *Master Attack Plan (MAP),* and the *Air Tasking Order (ATO).*[29] The MAP was assembled before the ATO, and was shaped by the daily intelligence, assessment, and planning processes that shaped the air battle. The ATO was the "administrative vehicle" used to transfer the daily plan to major air combat units, and provide the call signs, time on target, and other detailed information that combat unit commanders needed to execute the MAP. It reflected the work of a Joint Target Coordination Board (JTCB) and command review, by both Horner and Schwarzkopf, although planners and intelligence cell within the new Campaign Plans Division often made key targeting and force allocation decisions, and altered the MAP according to its own assessment of battle damage.[30]

This system had serious limitations. Chapters Five and Seven describe some serious problems in the way the MAP and ATO functioned, in the way offensive air war was managed and in the targeting process. Many aspects of C4I/battle management of offensive air operations during Desert Storm were too complex and time consuming, and depended heavily on months of targeting effort before Desert Storm. For example, in June, 1990, the USCENTCOM and CENTAF target lists had between 218 and 293 applicable

Copyright Anthony H. Cordesman, all rights reserved

targets. This list had expanded to 2,239 by early August, 1990, and 3,194-4,543 by January 15, 1991. This was more than a 40% growth between the invasion and Desert Storm.

The targeting system came under extreme stress during Desert Storm, as new targets like mobile Scud sites, new Iraqi C^4 facilities, and more railroads and bridges were added, and was only able to react because of the months of prior preparation. The number of potential targets grew to a total of 3,813-5,153 by the end of Desert Storm. More important, the number of key target sets grew from 481 on January 16, 1991 to 772 on February 26, 1991 -- a growth of 60%. [31]

The targeting system used to support C^4I/BM for air warfare either needed far more automation at every level from communications to analysis, or will be unwieldy and over-centralized in many future wars. The limits of the system were not fully exposed because the Coalition won and sustained nearly total air superiority, could execute the air campaign in isolation from the AirLand battle, and land forces were never threatened by effective Iraqi counter-attacks in a way that might have required a massive shift in the offensive air battle.[32]

Chapter Seven also shows that management of air attack assets over-centralized at the tactical level. By February 6, 1991, CENTAF was forced to adopt a system that used aircraft like the F-15E, F-111E and F-111B flying over 30 by 30 mile "kill boxes", where US strike aircraft could use data from forward air control aircraft and T-2 reconnaissance aircraft to strike at key Iraqi Republican Guard and armored formations on a target of opportunity basis. Attack aircraft were also assigned directly to Corps commanders once the land offensive began using what came to be called the "CAS flow" system. These aircraft only flew ATO derived sorties if the ground commander did not need them.[33]

The system also suffered from the fact the combination of US and allied communications could not handle the data handling burden, which presented problems in handling imagery and intelligence data. US Navy INMARSAT capabilities had to be used to link USN and CINCCENT capabilities. It did not prove capable of managing the sudden diversion of air assets to hunt for Scuds in the sense of providing a realistic assessment of kill capabilities, although it did adopt to the use of kill boxes, shifts to stand-off attack tactics, and a number of changes in the target mix.

The management of future air campaigns clearly needs more flexible command and control systems, and more advanced supporting technology. Near real time targeting and battle damage management capabilities must either be vastly improved to handle the problem of rapid theater-wide warfare, or the US must carry out most of the targeting effort against potential enemies in peace time that it carried out against Iraq during the period between August 2, 1990 and January 16, 1991. Less sophisticated, rapidly deployable,

Copyright Anthony H. Cordesman, all rights reserved

systems need to be created, to support power projection and coalition warfare, in "no warning" low to mid intensity conflicts. Finally, close study is needed of the trade-offs between centralized offensive air battle management and the allocation of specific air assets to land/sector commanders to determine when other methods of command and control will be more suitable.

However, all these problems and requirements must be kept in perspective. As Chapters Five and Seven also discuss, the Master Attack Plan (MAP) succeeded in many ways. The creation of an MAP capable of coordinating an air war as large as Desert Storm was a major achievement, and was only made possible by the fact that the Coalition had five critical months in which to integrate its air components into a central attack plan, and develop targeting list and procedures for strategic, interdiction, and air support activities.

The MAP/ATO system allowed USCENTCOM to steadily revise and expand US and allied targeting efforts before the invasion, to survey thousands of potential new targets, group them into a common target reference system and 12 target categories, and link targeting for the air campaign to targeting for the AirLand battle. Like so many of the lessons in Desert Storm, the issue is one of whether one wants to focus on whether the glass is one-fifth empty or four fifths full.

The JFACC was able to develop a dynamic process for changing target planning and altering the MAP and ATO to reflect new intelligence, weather factors, changes in the military situation, experience, and the results of battle damage assessment.[34] The JFACC was able to develop force packages based on the assessment of the best way to attack given targets, and provide a relatively compact 25-50 page daily overview of air operations, including the time on target, target number, target description, and supporting systems for each attack package. This not only could be done with an unprecedented coherence and speed, it could be done with an unprecedented fusion of the intelligence and battle damage assessment data that were available.

The Air Tasking Order (ATO):

The Air Tasking Order or ATO was the daily schedule that provided the detailed guidance to air crews necessary to implement the MAP. The ATO integrated a centralized implementation of the MAP with a centralized air refueling plan, and provided integrated special instructions for communications, reconnaissance support, land based control and communications support, and support from the E-3A AWACS, E-130 Airborne Battlefield Command and Control Center (ABCCC) and E-2Cs. It included long range B-52 attacks, and US Navy flights into Kuwait and Iraq, although not USN flights over water.[35]

This plan came to control more than 3,000 sorties per day over the KTO. The Coalition sometimes flew 600 aircraft over the area at the same time, and scheduled

Copyright Anthony H. Cordesman, all rights reserved

movements into and out of the KTO at one minute intervals. It succeeded in these tasks although previous US planning had never attempted to control more than 2,400 sorties a day, and was, at best, adequate for the sustained control of 1,500-2,000 sorties per day over a much larger theater. No aspect of US communications, data processing, procedures, or training before Desert Shield proved adequate to handle, even the USAF portion of daily planning for the air war, much less allied forces and the other US services. As Chapter Five describes, these problems were made worse during Desert Storm by serious problems in estimating and characterizing the Iraqi threat, and the failure of the battle damage assessment (BDA) process.

The ATO did have important defects.. It became cumbersome and often reached more than 300 pages in length. It did not always perfectly coordinate missions. It did not fully integrate US Navy operations. It had inevitable delays, and lacked adequate responsiveness to ground commanders. At the same time, it allowed US, RAF, RSAF, and other Coalition planners to coordinate the details of target assignments, route plans, altitudes, refueling tracks, fuel off-loads, call signs, and identification of friend or foe data.[36]

It is also important to point out that the MAP and ATO system was successful enough in initiating the air campaign so that the UN started Desert Storm by flying 2,759 sorties on the first day without changing the timing, target, or decision to fly a single sortie. The UN flew 2,900 sorties on the second day, changed the timing and targeting of 16 sorties, and changed the number by 69 sorties. Further, the ATO did adapt to changes in the conditions of war. The UN flew 2,441 sorties on the third day, changed the timing and target of 112 sorties, and changed the number by 449 sorties. It adapted to deal with problems in the availability of tankers, weather, the need to launch a massive "Scud hunt," and also adopted to changes in tactics like "tank plinking" and "kill boxes."

What was lacking in the JFACC/SPG/MAP/ATO process was a feedback system from the unit level that could make the central battle managers aware of the fact that they often made too many changes in the ATO too late for effective mission planning of complex strike sorties by aircraft like the F-15E and F-117. Some 23,000 ATO changes were processed during the war, 3,500 were timing changes, and 5,800 were target changes. The mission planning process often lacked the near real time processing and fusion systems necessary to do this efficiently.

Further, the MAP and ATO processes were degraded by the fact the Battle Damage Assessment (BDA) process was inadequate far too time consuming, and the intelligence effort to carry out BDA was largely decoupled from the operational needs of the air war. As a result, the planners developing the MAP and ATO had no way to change plans

Copyright Anthony H. Cordesman, all rights reserved

dynamically on the basis of accurate near real time BDA. in ways that assured a high degree of effectiveness. This problem was compounded by major problems in the BDA effort at the national and theater level, and by the belief of those developing the MAP and ATO that they had far more accurate BDA than was the case.[37]

Major problems also occurred in allocating air assets at the unit level. No wing or air unit commander, or division or corps commander, had access to the national and theater intelligence and analytic capabilities to target and assess damage. One aspect of air operations had not changed since World War I, World II, Korea, or Vietnam: Neither pilots or air combat unit commanders can judge their effectiveness in combat, and that pilot and unit reports of "kills" were generally highly untrustworthy. This was true even of video data for precision strike aircraft like the F-15E, F-117, and F-111F operating in clear weather. The fact that missiles and bombs appeared to track to the target and explode simply did not confirm a kill. Purely visual data from A-10, F/A-18, and F-16 pilots had almost no reliability, although some analysis after the war indicated that much depended on the specific pilots and that some pilots are far more accurate than others.[38] Yet, wing and squadron commanders, and pilots, received only limited feedback, analysis, and guidance from the BDA effort that did occur. Although air units were employing many systems and technologies that had never previously been used in combat, and most pilots and air commanders had no prior combat experience, the MAP and ATO system had no element that effectively used BDA data to support unit level operations.

Air Space Management System.

A major new Coalition command structure also had to be created to manage air space management and detailed aspects of air operations, such as the identification of friend or foe (IFF) system. Once again, much of this system had to be planned and created from scratch. Although a computer system for air space management was improvised and integrated into the TACC system during Desert Shield, no such system existed before the Gulf War.

Although up to 3,000 aircraft per day had to fly in a small air space, the US and its allies did not have even have the minimal capability to provide this kind of air space control until October, and it was only made possible by the creation of a central TACC, and the AWACS and ABCCC. By the time of Desert Storm, however, air operations required the management of 660 restricted operation zones, 122 airborne refueling orbits, 92 combat air patrol orbits, 78 strike corridors, 50 air transit routes, 36 training areas, 60 Patriot engagement zones, 312 missile engagement zones, 11 high-density air traffic control zones, 195 Army aviation flight routes, 38 major air corridors, 60 restricted fire areas, 60 no fire

Copyright Anthony H. Cordesman, all rights reserved

areas, 40 minimum risk routes, 17 air base defense zones, and numerous Aegis engagement zones.[39]

The final air space management system required the deployment or augmentation of not only the TACC, but of three host nation air control centers, seven radar approach control facilities, seventeen air base towers, and the deployment of 161 US controllers to US facilities, 85 US controller to allied facilities, 60 controllers in the liaison function, and 14 controllers on the CENTAF staff.

The success of system is one of the great successes of Desert Storm, and one of the great achievements of military history. It controlled over 110,000 sorties without a single aircraft collision, without any friendly fire by one aircraft on another, and with only minimal incidents of friendly fire by aircraft on ground forces -- none of which were traceable to the Coalition air control system.

At the same time, it is important to note that much of this success was due to the quality of the operator, and the use of strict flight rules, rules of engagement, and mission planning, rather than the proper exploitation of advanced C^4/BM technology, and the creation of the kind of flexible and adaptive system needed for a "revolution in military affairs." As will be discussed throughout the rest of this book, the system also only worked because many national air components were given restricted areas of operation and restricted missions. It did not solve the problem of integrating fixed and rotary wing operations. It worked around serious interoperability problems in the IFF and air control equipment used by different nations and military services, and it limited the flexibility of offensive air and AirLand operations. Air space management was a triumph, given the time available and the state of the art, but it was far from the system needed to take maximum advantage of air power and the AirLand battle, or the system needed for "perfect war".

Key Tools Supporting Command and Control of the Air War: The ABCCC, AWACS, Rivet Joint, and E-2C

The scale of Coalition airborne command and control activity during Desert Storm is illustrated in Table 4.1. It is clear from this table that the US flew over 90% of all such missions, although Royal Saudi Air Force AWACS also played a major role. This use of highly sophisticated airborne C^4I/BM assets was critical to every aspect of the air campaign described in Chapters Six and Seven. They allowed far more effective management of offensive, defensive, electronic warfare and intelligence, refueling, intra-theater airlift and heliborne operations. It provided a means of delegating key aspects of command and control to all-weather aircraft whose radars could look far deeper into the battlefield than land-based systems, which often had on-board electronic intelligence capability, secure communications and data handling capability, and the ability to manage a large number of

Copyright Anthony H. Cordesman, all rights reserved

aircraft at the same time. It was also essential to the JFACC command activity, and to managing so dense environment of air operations. The UN Coalition used these assets to play a giant game of four dimensional chess in which the movements reached peaks of over 600 aircraft flying over the KTO at one time.[40]

It is important to note, however, that such airborne command and control activities were only possible because of Coalition-wide air defense efforts that rapidly won and maintained the air superiority necessary to ensure the survivability of US command and control aircraft, and their freedom of action.[41] Further, the effectiveness of all airborne command and control capabilities depended heavily on prior British, French, and the RSAF exercises with US forces, on the lessons the Western members of the Coalition had learned in NATO, and on a long history of joint E-3B/C operations between the RSAF and USAF.

The E-3 AWACS (Airborne Warning and Air Control System) served as the Coalition's primary tool in managing the air campaign and air operations during the AirLand battle. The Gulf War marked the first use of the E-3 in a major air war, but it was a proven system which acted as both an airborne warning and surveillance platform, and as a control center for managing and tracking UN aircraft in their area of operation, and providing an airborne command element (ACE) to support the JFACC.

A mix of USAF and RSAF E-3s flew continuous command and control orbits about 110-125 miles south of Saudi Arabia's border with Iraq and Kuwait, and north of Iraq's border with Turkey. This force used 11 USAF E-3Cs based in Riyadh, Saudi Arabia; three USAF E-3Cs based in Incirlik, Turkey; and five Saudi E-3Bs. The USAF aircraft flew 448 sorties during the war for a total of 5,546 flight hours.[42] They maintained four aircraft airborne over Saudi Arabia (three to cover the border in front and one to manage refueling in the rear) and one aircraft airborne over Turkey. The Saudi E-3Bs flew an additional 303 sorties.[43] These aircraft provided airborne control for an average of 2,240 sorties per day, and of over 90,000 sorties during the war: About 85% of all sorties flown.[44]

The E-3s integrated data provided by RSAF, USAF, US Army, USN, and USMC air units, and used voice and digital data links to provide the bulk of the air battle status data given to the ground-based C2 stations. At the same time they were part of an information sharing net with the USAF RC-135 Rivet Joint Airborne Battle Command and Control Center (ABCCC) aircraft, USN E-2Cs, and the TACC. The TACC relayed air data to the Saudi-led Arab ground forces, the USMC ground forces, and to the US Army-led Coalition of US, British, and French land forces.[45]

The EC-130 ABCCC (Airborne Battlefield Command and Control Center) was used in Desert Storm for the first time. The ABCCC aircraft is an EC-130s carrying a 20,000 pound, 47-foot long, pod of equipment designed for battle management, rather than

Copyright Anthony H. Cordesman, all rights reserved

for radars or sensors. It was used to manage both strike and close support sorties, coordinate them with the advanced planning in the ATO, and to meet urgent tactical needs. The equipment on ABCCC aircraft can handle a battle plan covering an area of 2,048 by 2,048 nautical miles, and can receive real time data from the AWACS and other sources for all of the air tracks in the ABCCC's area of coverage. Twin computers provided this data to 15 workstations equipped with 19" monitors which showed vector and raster maps. These work stations could be used to track the position of up to 1,000 friendly and unfriendly aircraft in the area and/or threats like anti-aircraft and surface-to-air missile batteries. These tracks can also be compared to the tracks in mission plans which are preloaded into the ABCCC's computer in the form of optical disks.

Each ABCCC had four HF, four UHF, and four satellite radios, providing a total of 23 secure voice and two secure teletype circuits. Aircraft and weapons controllers on the ABCCC directed forward air control aircraft, airlift flights into the area under their control, reconnaissance and related electronic warfare aircraft, strike missions, and maintained constant contact with the AWACS and ground control and planning centers.

The USAF flew a total of 450 EC-130 sorties, of which 159 were primarily C3 sorties, 284 were electronic warfare sorties, and 7 were for other purposes.[46] The ABCCC aircraft functioned well, but it became clear that air battle management control activities required better software and displays, very precise navigation and location data, and high volumes of digital data traffic. The ABCCCs are now being equipped with GPS global positioning systems and improved Joint Tactical Information Distribution System (JTIDS) terminals as a result of the lessons of the Gulf War.[47]

US Navy E-2Cs also played a useful role in air control missions -- and flew 1,183 sorties and 4,790 flight hours, At the same time, they illustrated some of the limitations of less sophisticated airborne warning and aircraft. They could only fly 4.5 hour missions versus missions in excess of 11 hours for some E-3As. They lacked the over-the-horizon communications capability and in-flight refueling capability, they had substantially less capability to manage complex air battles, and had less radar range over land. Their sensors lacked a high level of tracking capability for low altitude targets over land, and operators had to be highly skilled to make use of the data available. Many of these limitations are being corrected in upgrades of the E-2Cs, but they are likely to be far more severe in most of the "mini-AWACS" aircraft now being proposed for sale, and often may make the aircraft inadequate for mid-to-high intensity air operations -- particularly where air cover cannot be assured.

This airborne command and control activity was heavily dependent on the availability and centralized control of US special purpose and high technology

Copyright Anthony H. Cordesman, all rights reserved

reconnaissance and electronic warfare systems that could not be provided by any other nation. For example, the RC-135V Rivet Joint aircraft were electronic intelligence collection platforms that flew a total of 197 sorties (43 reconnaissance and 148 electronic warfare) at stand-off ranges behind the perimeter posed by Iraq fighters. Their operations are discussed in more depth in the next chapter, but the RC-135s provided real-time data on the activity, location, and character of radar emissions by Iraqi fighters, air defense radars, and other emitters.[48] The role of the J-8A JSTARS is also described in Chapter Five.[49] While allied forces played an important role in such missions, Table 4.1 shows that US air assets flew 89-97% of all such missions, and played a dominant role in providing centralized high technology management of electronic warfare, airborne targeting and intelligence, and airborne damage assessment assets.

Dealing With Inter-Service Command Problems

The US, however, had a number of internal problems in using such assets. Bringing the US Air Force, US Marine Corps, US Navy, and US Army air assets under a single theater command created as many difficulties as US cooperation with the Saudis or RAF.[50] Debates arose between the Joint Chiefs, US Army, and US Air Force over the relative priority to be given to strategic bombing. These problems were compounded by a lack of integrated data processing and command and control systems that could substitute for physical co-location. Virtually every aspect of C^4I/BM for air operations during the Gulf -- such as the creation of bodies like the JFACC and Special Planning Group -- had an ad hoc character and this meant that related communications, data processing, displays, command support systems, and battle manage aids had an ad hoc character as well. Virtually every aspect of the related hardware and software reflected the pre-war failure to organize and equip a realistic C^4I/BM capability for a theater war more than half the size of the air campaign in Desert Storm.

The problems that developed between the US Navy and the US Air Force involved debates over air strategy, and control of forces. The US Navy and US Marine Corps did not have a well defined strategy for using air power in mid and high intensity regional conflicts before the Gulf War, but opposed the emphasis the USAF put on strategic bombing. The US Navy also argued that separate "route packages" for the allocation of combat aircraft should be developed under the control of each service, as had been the case in Vietnam. This inter-service rivalry was increased as time went on because the Navy felt that the JFACC was giving priority to the deployment of Air Force assets. This, however, may have been as much the result of the need to simply battle management by focusing on one force elements, and the fact that there was nothing approaching an adequate secure data-link and

Copyright Anthony H. Cordesman, all rights reserved

computer interface to handle ATO information between the JFACC and US carriers as any USAF parochialism.[51]

Some of the coordination problems between the US Navy and US Air Force also developed because Vice Admiral Stanley Arthur, the CINC of CENTCOM Navy forces remained at sea on the command ship "Blue Ridge," where he could not directly participate in planning the air battle because his dual responsibilities as Commander of the Seventh Fleet limited the time that he could spend on JFACC issues. While US Navy personnel were assigned to the JFACC in August, the key US Navy personnel planning the Naval portion of the air battle were not collocated with the JFACC. This seems to have helped create problems in structuring the detailed air tasking orders that also limited the efficient allocation of USN air assets.[52]

Coordination with the US Marine Corps and US Army should have been somewhat simpler because the JFACC was located near the C3IC, and because Schwarzkopf's deputy, Lt. General Calvin Waller, and the Commander of US ground forces, General Yeosock, worked closely with General Horner on a day-to-day basis. In practice, however, there were also serious problems in AirLand coordination.

Senior US Marine Corps personnel were not included in the planning of the air campaign. As a result, the MARCENT commander found that the USAF had planned to allocate Marine air assets centrally in ways that conflicted with the integration of Marine air and land assets in the Marine expeditionary forces. A major debate arose between the USAF and USMC over the independence that should be given to the Marine Corps in allocating its fighters to support USMC ground troops, and the Marine Commander argued that centralized planning under the JFACC was too inflexible and time consuming.[53] As Chapter Seven describes, this debate was eventually resolved by creating a special air control zone over the 1 MEF area during the land battle.

Serious problems emerged in coordinating the planning of the air and land campaigns because the air planning efforts within the JFACC were not integrated with the planning efforts for the land battle. This was partly the result of the fact that the planning of the land battle lagged behind the planning of the air campaign and partly the result of the fact that land and air planning were compartmented from each other until at least early November.[54] It was also partly the result of the fact that air planners focused on strategic bombing, while land planners focused on armored operations, and partly the result of the fact that many aspects of the air planning effort concentrated on fixed wing aircraft to the exclusion of rotary wing aircraft -- which were regarded as land assets. The lack of continuing high level interservice coordination in the JFACC and within the planning cell

Copyright Anthony H. Cordesman, all rights reserved

that General Schwarzkopf set up to plan the land battle probably contributed as much to these problems as of differences over strategy.

These problems during Desert Shield helped lead to additional problems between the air and ground commanders during Desert Storm. Marine and Army corps ground commanders wanted additional air strikes on Iraqi forward positions and artillery in the areas they were to attack, while air planners allocated strikes against the Iraqi rear and targets like the Republican Guards.

It is not clear in retrospect, that air planners were always setting different priorities from land planners. The air staff often seems to have been responding to General Schwarzkopf's emphasis on destroying the Republican Guard and preparing for a double envelopment, rather than pursuing a service oriented concept of operations. At the same time, USAF studies of the air operation during the Gulf War recognize that some form of joint air-ground board or review group should have been created to improve joint planning of air attacks in preparation for, and during the ground offensive.[55]

Almost inevitably, this complex mix of problems and differences led to a number of major disagreements between senior commanders. Admiral Arthur appealed several of the JFACC's decisions regarding the use of naval aircraft to USCINCENT, and Schwarzkopf resolved most in favor of central control by the JFACC. General Schwarzkopf also generally supported the JFACC during the war, when the Marine Corps and Army sought additional or more timely sorties.[56] At the same time, General Boomer succeeded in preserving a considerable amount of independence for Marine air units, and air attacks on Iraqi military forces were given priority over attacks on strategic targets.

These differences and debates illustrate the need for much closer cooperation between all four services in integrating AirLand planning, in developing common concepts for using the JFACC system, and for true the joint planning of air operations in mid to high intensity and theater level conflicts. This is a lesson that has since been adopted by the US Navy and US Air Force, which have conducted a number of joint exercises of a revised JFACC system using improved C^4I/BM systems and data links, as well as the transition from initial reliance on a sea-based JFACC to a land-based JFACC as reinforcements are deployed.

It is less clear that an effective joint planning system has been developed that fully integrates US Army and US Marine Corps planning of the land campaign with the planning of the air campaign and JFACC operations, or that effective solutions have been found for fully integrating fixed wing operations (including close support), rotary wing operations, and land maneuver warfare. The US did issue new joint doctrine in 1992, but it is unclear just how well this call for true jointness in JFACC operations will be put into practice.[57]

Copyright Anthony H. Cordesman, all rights reserved

Further, no system will ever deal with all of the criticism made during and after the war about over-centralization. Complex air battles are not capable of being managed by a committee or by fiefdoms, and no C4I/BM system will ever be able to made every need or avoid trade-offs that favor one legitimate war fighting need over another.[58]

Lessons from C4I/BM During the Air War:

Once again, the primary lesson to be drawn from this experience is the need to create and maintain a true C4I/BM capability to fight major air campaigns that can be quickly deployed to fight major regional contingencies anywhere in the world. There are, however, five other lessons that can be drawn from the Coalition's experience in C4I/BM during the air war:

- *First, that Coalition air warfare would be been radically different without US C4I/BM systems, and without an effective monopoly in such systems relative to Iraq. These capabilities not only revolutionized command and control in the management of the air battle, they also revolutionized the management of the AirLand battle, the tempo of warfare, and combined operations.*
- *Second, the US military and civilian bureaucracy failed to extend the "revolution in military affairs" discussed in Chapter Three to provide a realistic C4I/BM capability for theater warfare which could not even be improvised in the five and one-half months before Desert Storm. This lesson is repeated in many other areas in the chapters which follow.*
- *Third, it is not possible to compartment strategic attack, theater air , fixed and rotary wing, or land and amphibious battle planning and management without creating major command problems and operational debates. The US emphasis on jointness failed to bring the US Army, Navy, Marine Corps, and Air Force together into true joint planning and exercise efforts for large scale AirLand battles, and even the US Army and US Air Force focused far too much on NATO-Warsaw Pact conflicts to the exclusion of regional conflicts.*
- *Fourth, true jointness requires fully interoperable -- if not integrated -- C4I/BM systems that are rapidly deployable and which are fully tested through extensive joint exercises in peacetime. The existence of an office of the Assistant Secretary of Defense for C3I within the Office of the Secretary of Defense before the Gulf War did little to achieve this integration, and it was never given meaningful priority by the Joint Chiefs. No change in joint doctrine or the organization and procedures of the JFACC can, however, eliminate the need for effective hardware and software systems. Further, the "revolution in military affairs" will be dependent on such*

Copyright Anthony H. Cordesman, all rights reserved

systems for many aspects of the effort to increase the tempo, lethality, maneuver speed, and depth of joint operations.

- *Fifth, the more the US develops such integrated operations and C4I/BM systems , the more it will have to plan careful for coalition operations with far less integrated and sophisticated allied forces. This will be most important in terms of air operations -- which involve the most technically complex and high tempo battle management activities -- but will be a key priority in land and naval operations as well.*

These lessons are likely to be of critical importance in any future major regional contingency -- particularly one involving coalition warfare. The advanced C4I/BM capabilities that the US provided created problems as well as solutions. In spite of the time that the Coalition had to prepare for combat, many non-US air forces found it difficult to deal with the MAP/ATF system of air operations, and had to cancel missions because they could not rapidly adapt to changes in the ATO. A number of allied air units operated under significant mission restrictions because they could not adapt to US tactics and a US-dominated C4I/BM system. Coalition and cooperative warfare requires fully interoperable systems which are designed to control both US and less sophisticated forces.

The US is already making many changes in its C4I/BM capabilities as a result of Desert Storm. At the same time, force cuts and readiness cuts mean that much of the experience and capability that the US developed during Desert Storm has been lost or is being disbanded. There are some indications that the US preparation for air warfare in major regional contingencies has been underfunded, and that the US would still experience many of the build-up and equipment problems in fighting a future air war in Korea or in the Gulf that it did at the time of Iraq's invasion of Kuwait. It is one thing to plan and train for major regional contingencies, it is another thing to be ready to fight them.

Further, there is a real question as to how much progress can be made in these areas unless the US solve the Battle Damage Assessment problems discussed in the next chapter. High technology battle management requires much better near real time capability to measure the effectiveness of air systems, missiles, armored warfare systems, and indirect fire systems like artillery. These problems were scarcely critical during the Gulf War, given the Coalition's overall superiority relative to Iraq. Future wars, however, may take place against enemies with parity or near parity in "information warfare" capability and air and maneuver technology. They may take place against opponents which are capable of rapid innovation and adaptation. In such cases, the margin of victory may be determine by which side has the best ability to provide real time assessment of the effectiveness of its, and its opponent's, new tactics and technology. Targeting is only part of "closing the loop" in

Copyright Anthony H. Cordesman, all rights reserved

creating a C4/BM system that can dominate the action-reaction cycle in warfare. Providing accurate near real time damage assessment and effectiveness measures is at least as important.

Copyright Anthony H. Cordesman, all rights reserved

Table 4.1

The Impact of US Air Capabilities on UN Coalition Air Command, Control, Electronic Warfare and Reconnaissance Capabilities

Electronic Warfare and C4 Missions

	C4				Reconnaissance				Electronic Warfare			
	ABCCC	Early Warning	C4	Total	Recce	SLAR	Observ.	Total	ECM	ESM	EW	Total
US												
Air Force	201	379	24	604	869	0	442	1,311	0	190	1,388	1,578
Navy	1,143	0	0	1,143	1,190	0	241	1,431	5	260	0	265
Marine Corps	157	0	0	157	3	0	0	3	0	17	326	343
Special Forces	0	0	0	0	2	0	0	2	0	0	84	84
Army	0	0	0	0	0	147	0	147	6	547	15	568
Subtotal	1,501	379	24	1,904	2,064	147	683	2,894	11	1,014	1,813	2,838
Saudi Arabia	0	85*	0	85*	118	0	0	118	0	0	0	0
UK	0	0	0	0	156	0	0	156	0	80	0	80
France	0	0	0	0	62	0	0	62	0	0	0	0
Canada	0	0	0	0	0	0	0	0	0	0	0	0
Kuwait	0	0	0	0	0	0	0	0	0	0	0	0
Bahrain	0	0	0	0	0	0	0	0	0	0	0	0
Italy	0	0	0	0	0	0	0	0	0	0	0	0
UAE	0	0	0	0	6	0	0	6	0	0	0	0
Qatar	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal	0	85	0	85	336	0	0	336	0	80	0	80
Total	1,501	464	24	1,989	2,406	147	683	3,236	11	1,094	1,813	2,918
US as a Percent of Total	100	82	100	96	86	100	100	89	100	93	100	97

Note: The data cover the period from January 16, 1991 to February 28, 1991. There are significant national differences in definition, and some countries do not report special forces and support sorties. ABCCC = airborne battlefield command and control center. ECM = electronic countermeasures. ESM = electronic support measures or intelligence. C2 = command and control, C3 = command, control, and communications, and C4 = command, control, communications, and computers. CAP = combat air patrol SLAR = side looking airborne radar.

* These figures understate the role of the Saudi E-3s. Saudi Arabia reported 218 E-3 refueling missions and 85 C3 missions. The Saudi refueling missions were largely C3 missions. If the US E-3 missions are counted at 379 missions, this indicates that Saudi Arabia flew 44% of all E-3 missions.

Source: Adapted by the author from the data in Cohen, Dr. Eliot A, Director, Gulf War Air Power Survey, Volume V, Washington, US Air Force/Government Printing Office, 1993. The data are generally selected from the tables on pages 232-233, although some data and categories are modified to reflect different data in pages 235-386, and the detailed tables on pages 144-146 and 148-152.

Copyright Anthony H. Cordesman, all rights reserved

Other Lessons for Joint Warfare

The lessons the Gulf War teaches about the need for "jointness" are limited to the Coalition's experience with air C^4/BM. They are equally important in terms of intelligence, air operations, and the AirLand battle. At the same time, the Coalition's experience with C^4/BM highlighted the fact that even the US had a long way to go from a policy-level emphasis on integrating the operations of its military services and developing an effective joint war fighting capability. Although the US had increasingly stressed joint operations since the end of the Vietnam conflict, it encountered many problems in C^4/BM that had nothing to do with service policy or rivalry.

One key example of this problem was the fact that the US Army and US Marine Corps had not really planned to fight mid to high intensity major regional conflicts, and did not have the planning staffs, experience command structures, and C^{4I}/BM systems to prepare properly for Desert Storm. General Schwarzkopf attempted to solve this system by creating his own cell of planners, or "Jedi" for the land battle, but this staff inevitably lacked experience in planning even a large scale US Army land campaign, much less integrating the US Army plan with USAF, US Marine, and US Navy operations. As is discussed in Chapters Two and Nine, this helped lead to initial land warfare plans that failed to emphasize deception and maneuver, that called for a frontal assault on Iraqi defensive positions in the KTO, and which emphasize a one US Corps campaign, rather than decisive force. It also led to many delays in preparing the land portion of the battle plan.[59]

This inexperience also led to the compartmentation of the land planning effort from the air planning effort discussed earlier, and to a focus on US Army planning without proper coordination with the commander of the I MEF. Further, it may have contributed to the problems in battle management involving VII Corps discussed in Chapter Nine because Schwarzkopf's war planners were recruited long before VII Corps was added to the pool of US forces, and it is not clear that they had the level of experience and depth to fully appreciate the difficulties of planning sustain long distance armored thrusts.

Another key problem in jointness occurred at the technical level. As has been touched upon previously, US Navy communications and computer system lacked SHF communications. As a result, USN carrier forces could not execute on-line integration with the USAF computer-aided force management system. This meant that courier aircraft had to bring the ATO to the carrier which deprived the Navy strike/attack aircraft of mission flexibility.[60]

Copyright Anthony H. Cordesman, all rights reserved

These problems -- and a host of related smaller -- were serious enough so that the USN has fundamentally restructured its resource allocation to focus on joint operations. These changes were driven by the end of the Cold War, as well as by the lessons of the Gulf conflict, but they were enough of a lesson of the Gulf War for the officer in charge of acting on the lessons of the conflict to state that,[61]

> "We have reformed our resource allocation process...In order to improve the Navy's ability to integrate seamlessly with the AirLand Battle and to emphasize the importance of joint operations, we have created the Naval Doctrine Command in Norfolk, Virginia. We have already seen positive results in the areas of tactics, techniques, and procedures, and have incorporated these into recent predeployment workshops. Also of note are recent joint exercises where Naval Commanders have served as Joint Force Commander (JFC) and/or Joint Forces Air Component Commander (JFACC) afloat. We believe that this capability is critical if we are to serve effectively as the joint force enabler during the early days of the conflict....In sum, we have changed our strategy, our force structure, our organization and our budget process since Desert Storm."

The Navy has dealt with the problems of integrating US Navy and USAF ATO activity by developing and deploying an SHF Quicksat to provide the needed joint connectivity. This interim fix allows future JFACC commanders ashore to pass the ATO electronically to carriers at sea, and allows embarked commanders to serve as a shipboard JFACC in small operations. The USN is also developing a more permanent solution called the Contingency Theater Automated Planning System (CTAPS), which will provide a fully automated and interoperable air and strike missile C^{4I}/BM, and which will be installed on all of its carriers and fleet flagships.[62]

There were, however, many similar problems. The US Navy and USMC had not fully solved the C^{4I}/BM of cooperating with each other, and had tended to evolve a C^{4I}/BM system oriented towards power projection for low to mid-intensity amphibious warfare while the US Army and USAF had emphasized the AirLand battle in Europe. The US Navy had not emphasized cooperation with the US Army.[63] Many C^{4I}/BM systems within US forces were not truly interoperable -- with problems in range, frequency compatibility, standardization of geographic coordinates, traffic volume, compatible automation, use of digital versus voice systems, and a host of other technical and connectivity problems. Few of these problems were major individual barriers to war fighting, but cumulatively, they presented problems that greatly increased the problems that the US faced in creating an effective C^{4I}/BM system during Desert Shield, and which affected many aspects of the air campaign and AirLand battle.

Copyright Anthony H. Cordesman, all rights reserved

These examples help explain why one of the key lessons that the US has drawn from the Gulf War is that it failed to properly anticipate the full requirements of joint warfare at virtually every level of military planning and operations and that joint warfare and combined operations must be further developed to new levels. The US had 51 new joint publications as a result of the Gulf War by mid-1994, and more than 50 additional publications still in process. The US army was working to make further major revisions in its field manual on operations (FM-100-5), and many key areas of joint operations were undergoing comprehensive review, and being tested in war games and exercises.

The Assistant Secretary of Defense reporting to Congress on the lessons of the Gulf War stated that work accomplished as of 1994, " will (only) complete the initial stage of joint doctrine development. The next phase of our efforts will be to refine and fully integrate this joint doctrine into our training and exercises." He also went on to tie these changes directly to the C4/BM problems in the Gulf War,[64]

> "To give you a clearer picture of the lessons learned regarding joint doctrine, let me address one of the most challenging doctrinal problems that we experienced during Desert Storm: planning and carrying out joint air operations. While our services worked exceedingly well together in the execution of air operations, two issues emerged in the preparation stages: (1) whether the planning cycle for developing the daily air tasking order (ATO) is capable of keeping up with the accelerating pace of modern warfare, and (2) whether the Joint Force Air Component Commander (JFACC) should be a commander or only the coordinator of aviation assets in the theater. The Gulf War validated the compatibility of the ATO process with maneuver warfare and with the need for the JFACC to provide central direction under the oversight of the Joint Force Commander for theater air operations. Joint doctrine now clearly supports this role for the JFACC, and the services as well as the unified commanders have begun refining and exercising this role. Exercise Tandem Thrust 93, conducted in July 1993 by the US Pacific Command, successfully executed a service transfer of JFACC command as operations moved from sea to land."

Whether the US will be as successful in achieving its ends as this statement implies is an open question. It has made joint C4I/BM a major thrust in its training, technology programs, as well as its doctrine and exercises.[65] However, every advance in other aspects of joint operations ultimately imposes new strains on joint C4I/BM. The US Defense Science Board (DSB) noted in its 1992 study of the lessons of the war that it is far easier to see the need to support joint warfare that it is to provide it. The Defense Science Board found that the US C4I/BM system it examined still, [66]

Copyright Anthony H. Cordesman, all rights reserved

> "produced the lack of readiness which characterized our posture on August 1, 1990, the lack of interoperability of the force deployed, the failure to anticipate sensor and weapons interactions, which became so obviously necessary during Desert Shield, the failure to realistically exercise this contingency scenario and learn from it when it was recognized as the most probable use of military forces. It is the same structure that has consistently failed to address the identification process in a comprehensive way, failed to create and practice concepts for BDA for the weapons and sensors which were clearly evident, and failed to anticipate the roles that space sensors, communications, and navigation systems would be required to play in this, the most likely application, of US forces...The basic institutional processes have not changed.

Jointness, however, is scarcely an American problem. Other nations have smaller force structures, and may not encounter the same problems to the same degree. However, Britain was the only other Coalition power to demonstrate a significant capability for combined and joint operations during the Gulf War, while the RAF exhibited a number of problems in its C4I/BM and weapons systems that limited its ability to provide support to the land battle. The RSAF lacked effective C4I/BM and training to support the Saudi Army. French forces lacked the night vision systems and C4I/BM for high tempo AirLand battle operations. While other nations may not have to plan for independent power projection in mid to high intensity conflict, their jointness problems will be even more severe if they then have to try to improvise joint C4I/BM systems with other countries.

The Need for a New Structure of C4/BM for the AirLand Battle in High Tempo mid and High Intensity Conflict

The following chapters are filled with examples of the fact that the Gulf War shows that any nation that fights mid or high intensity wars in a coalition with the US will have either to adapt to the evolving American concepts of jointness and to American C4I/BM systems, or will be unable to play a fully effective role in combat. This lesson is illustrated by the problems that the Coalition encountered in creating C4I/BM capabilities for the AirLand battle. This was a Coalition-wide effort, and one of the most demanding in military history. By mid January, 1991, the Coalition's communications systems, and the connectivity between the various elements of Coalition forces and their military services, was more advanced than that of NATO. In fact, by November, 1990, US experts estimated that, "there was more strategic connectivity (circuits, telephone trunks and radio links) in the area of operations than in Europe." [67]

At the peak of Desert Storm, a wide mix of different types and generations of command and communications equipment had been coordinated into an architecture that

Copyright Anthony H. Cordesman, all rights reserved

could handle a peak of 700,000 telephone calls, and 152,000 messages per day, and a mix of communications and other emitters involving over 35,000 frequencies. The sheer scale of the C^4I operation is also indicated by the fact there were more than 2,500 joint circuits, and more than 7,500 high frequency, 1,200 VHF, and 7,000 UHF different radio nets. [68]

This effort involved a massive effort by every national contingent, as well as the Saudi telephone service. Every nation was forced to improvise and then work around the inevitable limitations of equipment and systems designed for a different intensity and type of operations. France, for example, had to make some modifications in its RITA system to make it more compatible with the US Army MSE communications system. While there were many individual failures, and every country experienced serious equipment problems of some kind, each was able to develop enough capability and "work around" over a period of months to avoid critical or catastrophic failures.[69]

The Key Role of Satellite Communications

At the same time, virtually all high density Coalition-wide command, communications, data handling, intelligence, and reconnaissance systems had to be deployed by the US. The US near-monopoly of space-based communications and intelligence systems played a key centralizing role in every aspect of C^4I, and in providing a unity of command that cut across the formal lines of command. The space order of battle used in Desert Storm is shown in Table 4.2. This table cannot accurately describe the wide range of US intelligence satellites that played a critical role during the conflict, or show the importance of some of the military capabilities provided by other US satellites, but it does provide a clear picture of the number and complexity of the space systems that were used to support Coalition C^4/BM activity.

US space warfare capabilities affected both air and AirLand operations, and were particularly important in ensuring that the Coalition could achieve surprise and execute high tempo and joint operations during the AirLand phase of the campaign. High density satellite communications were critical to coordinating Coalition operations during Desert Shield, as well as to managing the projection of US forces and movement of supplies from the US, Europe, and other parts of the world.

The US had to provide most of the communications links between the theater and Europe, most of the Coalition's in-theater secure communications and intelligence dissemination assets, and the heavy tropospheric communications support and line-of-sight communications equipment used for intra-theater connectivity. It provided a major augmentation of Saudi command and control ($C^{2)}$ assets, including US liaison teams with Saudi forces, C^2 systems for the Saudi Northern and Eastern commands, and 100 secure high frequency radios and add-on encryption equipment for other Saudi systems. It also

Copyright Anthony H. Cordesman, all rights reserved

provided the secure phones, personal computers, and secure FAX machines lacking in many Coalition forces and national headquarters.

While the provision secure telephones and FAX systems may seem mundane, they were critical to permitting the free flow of secure command and control information, and the Gulf War was the first time in history that such communications were widely available to commanders. The US deployed over 350 secure STU-III telephones and related secure FAX capabilities in the theater. Although these systems exhibited a number of important limitations, they still proved critical to improving the speed of targeting and tactical communications with technical and supply centers.[70]

The US provided virtually all of the satellite systems used for inter-operable Coalition-wide communications.[71] At the peak of Desert Storm, the US deployed 118 GMF communications satellite terminals in the theater, 12 commercial satellite terminals, 61 TRI-TAC joint tactical communications program, voice and 20 TRI-TAC message switches. The US provided five ground mobile force/defense satellite communications systems to British forces as they assumed a major role in VII Corps operations -- although the US, in turn, made extensive use of British SKYNET satellite capabilities.

The Defense Satellite Communications System (DSCS) was particularly important, although the new MILSTAR communications system was not deployed, and had not yet been restructured from a focus on the Cold War to conventional theater war fighting capability.[72] This system consists of satellite, control, and terminal segments. At the time of Desert Storm, it had five satellites in orbit and three in reserve, although demand reached the point where an additional satellite had to be provided. The use of the system grew rapidly during Desert Shield, and the number of terminals grew from 4 at the time of the invasion to 120 by January 5, 1991.

The DSCS furnished about 75% of intra-theater connectivity during Desert Storm, and handled functions like intelligence exchanges with the US, disseminating the ATO, and mobile satellite communications during the AirLand battle. A total of 33 ground mobile terminals went forward with commanders into Kuwait and Iraq during the AirLand phase of Desert Storm, many with their antennas mobile on flat-bed trailers. These terminals were often critical to allowing disperse units to communicate, and experimental lighter satellite receiver units proved equally valuable at the lower echelons where they were deployed on an experimental basis.[73] While many aspects of the DSCS were limited in volume and capability by the age of the system, and the mobile terminals were too heavy, difficult to maintain, and vulnerable to jamming and spoofing, the system was critical to ensuring integrated command of maneuver during the land operations.[74]

Copyright Anthony H. Cordesman, all rights reserved

US UHF satellite communications played a major role in logistics communications and intelligence dissemination, and the UHF TACSAT was extensively employed when military FM radios could not provide the necessary range. This overburdened US global UHF satellite capabilities, even though a US research satellite was modified to provide increased coverage. The US also had to lease commercial communications satellites, and mix three different generations of older analog and digital communications systems in the theater.[75]

Copyright Anthony H. Cordesman, all rights reserved

Table 4.2

The Space Order of Battle in Desert Storm

Function	Satellite System	Number of Satellites Deployed		Type		
		August 2, 1990	January 16, 1991	Military	Civilian	
Communications	**Defense Satellite Communications System**					
	DSCS II	2	2		X	
	DSCS III	4	4		X	
	FLTSATCOM	2	2		X	
	LEASAT	2	2		X	
	GAPFILLER	1	1		X	
	Skynet (UK)	2	2		X	
	NATO 3	1	1		X	
	INTELSAT	4	4			X
	INMARSAT	1	1			X
	LES-9	1	1			X
	DARPA MACSAT	1	1		X	
Meteorology	**Defense Meteorological Satellite Program (DMSP)**	2	3		X	
	NOAA TIROS	2	2			X
	METEOSAT (Europe)	1	1			X
Multi-Spectral Imagery	LANDSAT	2	2			X
	SPOT (French)	2	2			X
Navigation	NAVSTAR Global Positioning System (GPS)	13	16		X	
	TRANSIT	7	7		X	
Early Warning	**Defense Support Program (DSP)** Missile Detection	2	3		X	
Surveillance & Intelligence	Lacrosse Radar	1	1		X	
	Keyhole (KH) Imagery/ SIGINT/ELINT	5	7		X	
	Vortex SIGINT/ELINT	3	3		X	
	Magnum SIGINT/ELINT	3	3		X	

Note: Key systems are shown in bold. A reserve DSCS II satellite was repositioned from the Pacific to the Indian Ocean in December, 1990. The launch of a third DMSP satellite had to be accelerated to December, 1990 to supplement existing DMSP and NOAA (National Oceanographic and Atmospheric Administration) and TIROS (Television and Infra-red Observation Satellites). The LANDSAT and SPOT were used for mapping, but this part of the table excluded important intelligence capabilities. A third DSP satellite was deployed in December, 1990 to improve coverage of Iraqi Scud launches.
Source: Adapted from: Eliot Cohen, ed., Gulf War Air Power Survey, Volume V, Washington, GPO, 1993, pp. 126-132, testimony by General Donald J. Kutyna, CINC US Space Command before the Senate Armed Services Committee on April 23, 1991, pp. 23-25, and Desmond Ball, The Intelligence War in the Gulf, pp. 5-15.

Copyright Anthony H. Cordesman, all rights reserved

The Need for Improved Tactical Communications

The need for improved tactical communications is another critical lesson of the Gulf War. The fact that various elements of British, French, and US Army forces had relatively modern digital C^4 systems reduced some of the burden on the Coalition-wide systems, and allowed a more effective interface between theater-wide and national systems. These systems, however, often required modification and contractor support to adapt them to the special needs of Coalition warfare and Desert Storm. The US, for example, found that US Army and USMC tactical communications were not fully interoperable, and had to make software modifications on Marine ULCS communications. Such problems led the US to create a far more intensive test and evaluation effort to examine the interoperability of its systems at the Joint Interoperability Test Center of its Joint Tactical Command, Control, and Communications Agency.

The US again found, however, that the older family of VRC-12 radios in its land forces lacked the reliability, effective and predictable range, ability to operate in poor weather, secure communications capability, and reparability to meet the needs of modern warfare at any intensity of combat.[76] It had better experience with its new digital Single Channel Ground and Airborne Radio Systems (SINCGARS) radios. These are relatively lightweight systems weighing 19.6 to 22.5 pounds. They have a frequency range of 30,000-87,895 MHz; a choice of 2,320 channels, and a range of 8-35 kilometers. Their 1,250 hours MTBF specification is far superior to AN/VRC-12 and AN/PRC-77, and it has improved ECCM capability, and communications security through an integrated device or through the external VINSON system.

The US employed roughly 1,050 SINCGARS radios, 700 with the Army, 350 with the Marines, and additional units with Special Forces.[77]SINCGARS was an improvement, but drew mixed reviews in the field. Reports indicated that the system experienced approximately 7,000 hours mean-time between failure, compared to the 200-300 hours demonstrated by the VRC-l2. The 1st Cavalry Division used SINCGARS at retransmission sites, and experienced about a 30 percent increased range capability. Special operations forces also complimented the radio's light weight, which provided better rough terrain reliability, and better all-weather capability.

As Chapter Eight discusses, however, the range improvement that SINCGARS provided was not sufficient for the needs of XVIII and VII Corps, and it did not have adequate data throughput and data transmission speed within and between nets. A number of those who used SINCGARS felt that the Army over-praised the system, and underestimated the need for highly portable satellite communications. They also felt that

Copyright Anthony H. Cordesman, all rights reserved

there is an urgent need for a zero-based review of the tactical communications capability in US Army and USMC forces.

Although there is no way to confirm the validity of such criticisms, they were common enough to indicate that even a fully deployed SINCGARS system could present serious problems in high intensity AirLand operations, and particularly in complex, medium to long range maneuver operations under the pressure of significant enemy pressure. These problems have led tro an upgrade program to improve SINCGARS since the war that will provide a GPS link, four times the data throughput, better digital data handling capability, and a new internet controller.[78]

It is not clear how well every aspect of the British Ptarmigan-oriented and French RITA-oriented tactical communications systems functioned. They clearly met critical tactical needs, but British and French forces did not maneuver on the scale of US forces, and were supported by US theater communications systems. Interviews with Arab commanders indicate a number of communications problems, but so many were linked to a lack of corps or task-force level battle management systems that technology rarely seemed to have been a key factor. In the case of Egyptian and Saudi forces, the failure to conduct adequate pre-war training for large scale combined arms operations, and to evolve a suitable battle management system based on such training, was almost certainly the prime cause of many of the problems that Arab commanders encountered.

Tactical Communications and C4I/BM: The Potential For "Fusion"

US planners believe that the Gulf War demonstrates the need to develop a fully integrated theater and tactical communications system that can be rapidly deployed for the AirLand battle. Their efforts to develop such a system are still evolving, but one approach includes a tri-band satellite communication system that would combine advanced voice and data links with light weight hardware. If it is fully funded and deployed, this system will break away from the past reliance on dedicated military communications and allow the Army and Air Force to operate over a wide range of both commercial and military frequencies. The Army and Air Force agree that satellite links are essential to avoid the traditional distance, terrain, and weather problems that affect point-to-point theater C^4/BM, and that use of a very wide range of frequencies is essential to avoid the problems in combining voice and data communications, and prevent the clogging of military frequencies that took place in the Gulf conflict.

The tri-band terminals will use both DSCS satellites and commercial satellites like the Intelsat, and portable terminals derived from the US Air Force portable multi-band satellite terminal program. Instead of the large terminal used during the Gulf War, each of which filled a C-130, the services are seeking a system that will not only be more capable,

Copyright Anthony H. Cordesman, all rights reserved

but whose terminals will be about one-third the size of the Gulf War system. These units are planned to be trailer mounted and weigh about 6,500 pounds. The US Navy is beginning to explore a similar approach.[79]

Such a system, however, is more an answer to the connectivity problems encountered in the Gulf War than to the battle management problem. As Chapter Nine discusses, the US is also examining options for a far more sophisticated battle management system than the one it used in the Gulf War., The US Army is already experimenting in simulations and exercises with a "digitized battlefield" that potentially could "net" every aspect of theater and tactical C^4/BM from individual major weapons like tanks and artillery to the theater command. This system would create a complex hierarchy of real and near real time communications and information management that could integrate data from an imagery satellite, from a theater platform like the JSTARS, and a tactical RPV with command and control data. Deployment of such systems is at least 10 years in the future, but the US Army very clearly sees the need for such a system as a lesson of the Gulf War.[80]

Lessons for Future Medium/High Intensity and Coalition Warfare

The tactical importance of the network of US-dominated control, communications, and intelligence systems that the Coalition used during the Gulf War is sometimes understated in discussions of the future role of UN commands or international peacekeeping efforts. So is the importance of the other elements that are essential to the effective ability to command high tempo operations; effective integration of maneuver, firepower and sustainability, and night and all weather operations. In practice, however, the impact of US control, communications, and intelligence systems on the outcome of the Gulf War offers several important lessons for the future:

- o High tempo AirLand and armored operations of the kind fought in Desert Storm will be dependent on spaced-based communications support, just as they will be dependent on airborne command and control facilities.
- o The creation of an effective communications system for Coalition warfare was as time dependent as logistics and power projection, and was not in place until mid-November. There is a clear need to be able to rapidly project global C^4I capabilities suited for high intensity warfare.
- o No UN or international C^4I organization will be as remotely effective as a US-dominated command structure, or as able to execute high tempo joint operations with the same effectiveness. The US will not transfer its assets to the UN, the UN cannot afford to re-create them, and the assets can only be effective if a core group of forces is constantly trained to use them.

Copyright Anthony H. Cordesman, all rights reserved

- o Coalitions without the US will face major operational limits relative to the UN forces in Desert Storm. High volume, long distance, secure, and intelligence related C^4I systems are likely to be critical operational problems in mid to high intensity conflicts, and could prove critical in many multi-national peacekeeping and low intensity operations.
- o The shift to satellite communications created a demand that rapidly exceeded supply. This affected virtually every aspect of communications and intelligence activity, and potential demand continued to growth throughout every day of Desert Shield and Desert Storm. The upgrading of many systems, especially the DSCS, is clearly needed and is underway.
- o In spite of its satellite capabilities, the US had inadequate Army and Marine Corps tactical communications. Desert Storm demonstrated the need for rapid conversion to modern long-range secure digital communications systems to support AirLand and high-tempo military operations. It also demonstrated the need for more demanding tests of interoperability and capability for joint power projection in mid-intensity and high-intensity conflicts, and for the further examination of problems in the range and poor weather performance of tactical communications systems.

These lessons do not imply, however, that the solution is always more equipment, more sophistication of C^4I/BM systems, or more centralization. Some aspects of the growth of C^4I/BM systems during Desert Shield and Desert Storm revealed a tendency to overburden various echelons with communications, and layer systems without proper regard to the delegation of authority and the practical limits of the ability to use information at given levels of command. Because C^4I/BM systems were improvised under the pressure of a continuing crisis, the answer to virtually every problem tended to be to rush in more equipment or layer more complexity. This, in turn, placed more strain on equipment and systems capabilities and might have led to considerably more serious problems if UN Coalition had faced a more capable opponent or had had to exercise C^4I/BM in more complex ways -- such as adding a major amphibious operation to AirLand operations, or fighting a more intensive naval battle.

Similarly, it is far from clear that trying to meet all the potential demand for added satellite communications capability is cost-effective, or that unconstrained growth of space communications systems is a lesson of the Gulf War. Some analyses of the lessons of the war do focus on the need for larger satellite systems, a reactive satellite capability for major contingencies, and the modernization of older satellites. The may well be a need for a comprehensive and ongoing US effort to create an improved satellite and communications architecture for major regional contingencies. However, creating ever more complex and

Copyright Anthony H. Cordesman, all rights reserved

expensive solution to the C4I/BM problems of the Gulf War is clearly not an affordable answer for nations other than the US, and may be unaffordable for the US as well.

The Gulf War may be a warning that the US also needs to fundamentally rethink its C4I/BM architecture to the need for some kind of satellite and high cost system, rather than continuing to provide increased equipment and capability. In practice, the answer to "how much is enough?" cannot always be "more!" It also cannot be improvisation, where the alternative to "more" is often "failure". The Gulf War is also a lesson that the search for simplicity, independence of operations, and the proper delegation of command authority, remains just as important an answer to the C4I/BM problem of the Gulf War as more equipment and higher technology.

The Value of Critical New Elements of Command and Control: The Impact of Global Weather and Navigation Systems

Many members of the Coalition had greatly improved their night vision and all-weather warfare capabilities for both air and land operations. As will be discussed throughout the following chapters, these improvements played a major role in the UN Coalition's success in strike/attack operations and in the encounters between Coalition and Iraqi armor. There were, however, two US systems that played an important role in providing the Coalition with additional C4I/BM capability, and in ensuring the coordination of operations at high tempos of combat.

- *Defense Meteorological Satellite Program (DMSP):* The Gulf War was the first war to be fought with support from advanced weather satellites.[81] The UN Coalition made use of three Defense Meteorological Satellite Program (DMSP) satellites, for both air land operations, with the central dissemination of most data to the UN ground forces from the USAF ground station in Riyadh. The US Army used commercial terminals in the field, because the larger military Mark IV van lacked mobility, and placed a high air load requirement.

  Weather data is important in all conflicts, but was of special importance in Desert Storm because the weather was bad from G-Day to the end of the conflict, and because of record rains, sandstorms, and smoke from the oil fires of nearly 700 wells. Cloud ceilings at 10,000 feet over Baghdad and Kuwait were twice as frequent as was predicted before the war, and possibly the worst in 14 years; Nearly half of the attack sorties that aborted or failed to hit their targets early in the weather were due to weather. The DMSP was important in predicting the windows in the weather when UN strike/attack aircraft could see their targets, and in planning the

Copyright Anthony H. Cordesman, all rights reserved

right munitions loads and strike profiles to deal with poor weather conditions. It also played a major role in allowing UN land forces to take maximum advantage of their all-weather and night vision systems., in countering fogs and bog areas.[82]

One of the lessons of Desert Storm is the need for smaller and more portable military terminals that can receive and disseminate high resolution weather data. Another lesson is that expanding the depth of the battlefield and the tempo of operations requires excellent theater-wide weather data, and the ability to accurately predict transient weather conditions over both the expanded battlefield and interdiction targets.

o The NAVSTAR Global Positioning System (GPS): The ability to target and kill at long ranges, to fight at night and in poor weather, to move rapidly across rough and sandy terrain, and to navigate precisely are all critical aspects of Desert warfare, and "owning the desert". It is one of the anomalies of Desert Storm that Iraq was sharply inferior to the UN in all four areas, and that it was forces trained and organized to fight in Western Europe -- not in Iraq -- that "owned the desert." Many of the reasons for Iraq's failures have already been discussed, but the NAVSTAR Global Positioning System (GPS) played a key role in allowing Coalition forces to precisely locate themselves in real time and use a common reference, regardless of the visibility and terrain features.

Early deployments of the GPS immediately demonstrated the value of the system, and created a demand far greater than US planners had anticipated. The GPS came to be used for aircraft and helicopter navigation, for precisely locating forward air controllers and electronic intelligence systems, guiding maneuver units, individual tanks and LAV's, reducing fratricide, locating artillery and mines, fixing positions during mine clearing operations, and for providing launch coordinates for ships firing cruise and SLAM missiles.[83]

Exercises quickly showed that the GPS system helped free Coalition land units from being road bound, and greatly improved the tempo of land operations. They also proved to be of great value in allowing helicopters to navigate over an often featureless desert and water.[84] Demand rose steadily and the official US count of authorized GPS receivers rose to 842 military receivers (16 meter best accuracy) and 4,490 commercial receivers (25 meter best accuracy), and there may well have several hundred more unofficial commercial units. The number of authorized receivers in the Saudi and European Coalition forces rose from 24 to 2,000-2,500.[85]

The GPS became so popular that it raises several lessons about future warfare: First, military forces need to be fully equipped with GPS receivers and adequate coverage

Copyright Anthony H. Cordesman, all rights reserved

needs to ensure their ability to provide accurate latitude, longitude, and altitude data. Second, all US and friendly forces need to be equipped with ample numbers of secure military units with cryptographic capabilities, and be trained to use them. Third, regardless of pressures from civilian users, more advanced methods are needed to ensure that potential enemies cannot use the system or get misleading results, and the US needs to make extensive use of the ability to intentionally corrupt the data being provided to non-secure units, and develop deception techniques to surprise and disrupt enemy forces using commercial units. Fourth, friendly forces need to be instructed not to use commercial units in wartime, when misleading results could present operational and fratricide problems. Finally, there are some indications that the current corruption technique only degrades accuracy and does not support major deception operations. This needs careful evaluation, particularly in view of the potential use of such systems in cruise missile guidance.[86]

Lessons for Countervailing Strategy: Iraqi Command, Control, Communications, and Battle Management (C^4/BM)

There is little point in going into great detail about the Iraqi C^4I/battle management system. Its major problems have been summarized in the previous chapter, and insufficient data are available to assess the detailed impact of its organizational and technical weaknesses, or to separate out the problems caused by authoritarian over-centralization, weaknesses in doctrine and tactics, and problems inherent in the system.

The Iraqi system did have strengths as well as weaknesses. It used optical fibers, and made extensive use of modern radio communications, and land lines -- including some that were hardened. There were coaxial land lines running next to the Tigris and Euphrates from Baghdad to Basra, westward towards Jordan, and north to Mosul. There were fixed and mobile microwave relays that duplicated these land lines, and there were fiber optic lines running along the strategic pipeline from Baghdad to Basra and into Kuwait. There were at least four massive bunkers to protect the leadership (under the new Presidential Palace, and in North Taji, Al Firdos, and Abu Ghurayb), and Saddam Hussein had a group of 24 Bluebird trailers that he used as mobile leadership site.[87]

Table 4.3 provides a rough picture of the sheer scale and complexity of the Iraqi C^4 system -- although it ignores thousands of smaller command and communications node. The Iraqi system also had many different centers, include several massive underground sheltered facilities. Coalition targeting data list a total of over 690 major C^4 sites, and 270 military leadership and support sites, plus well over 1,000 other sites with some sort of major C^4 facility.[88]

Copyright Anthony H. Cordesman, all rights reserved

These features allowed the Iraqi system to retain considerable capability and connectivity in spite of the Coalition bombing effort. Although the Coalition flew nearly 600 strike sorties against Iraqi C^4 sites, and nearly 300 against leadership targets, -- including over 400 F-117 stealth strikes, some cruise missile strikes, and a limited number of F-111 strikes -- it did not prove possible to effectively "decapitate" the Iraqi leadership or even shut down many major telecommunications capabilities. The Coalition faced too large a target base, it was too well protected, and effective UN air and missile strikes meant massive strikes on civilian buildings, facilities which were also used as civil defense centers, and urban bridges (which were used to protected fiber optics in river crossings). [89]

In practice, however, it was the weaknesses in the Iraqi system that prevailed, and the following list of weaknesses may well be an important lesson in the kind of weaknesses that can be expected in other Third World forces:

- *Authoritarian over-centralization and intervention:* Far too much of the Iraqi C^4I/BM system reported to Baghdad or could be bypassed by Saddam and the Ba'ath elite. At the same time, it was organized and accustomed to micro-management at the political level.
- *Compartmentation:* The system was divided into many separate sub-systems that had severe difficulty in "talking" to each other. These occurred at the inter-service, branch, and regional level. They also affected some aspects of communications between the Revolutionary Guards and regular army.
- *Lack of secure communications:* While extensive secure communications did exist, the Iraqi system was at best capable of commercial levels of security, and was vulnerable to Coalition COMINT and SIGINT capabilities. Iraq tried to deal with vulnerability this by radio and emitter silence, but this -- in turn -- severely limited operational capabilities.[90]
- *Hierarchical non-redundant centers and nodes:* In some cases, the system could not effectively recover from the loss of a major headquarters of facility at the top. It could not reconnect around a missing node.
- *Rigidity:* Far too many procedures were too rigid. Little or no training existed in rapidly adapting C^4I/BM systems to new functions or adapt to changes in the nature of battle.
- *Lack of automation, inadequate software, use of partially incompatible foreign systems, over-reliance on voice or low rates of communication:* The Iraqi system was tailored to the much slower pace of the Iran-Iraq War and peacetime needs. It lacked adequate automation, and doctrine and training for anything approaching the UN air campaign and AirLand battle.

Copyright Anthony H. Cordesman, all rights reserved

- *Ground controlled intercept (GCI) system:* Iraq's air defense capabilities were crippled by the adoption of some of the worst aspects of Soviet C^4 capabilities. Fighter combat was heavily dependent on being successfully vectored to targets by secure survivable ground centers using survivable radars under conditions largely immune to enemy electronic warfare -- a problem compounded by poor fighter pilot training and limited on-board radar and avionics capability. This was a lesson that also struck some Russian observers.[91]
- *Design defects and over-centralized control of surface-to-air missile defenses:* The problems created by a reliance on GCI intercepts was compounded by a ground-based C^4/BM system to control heavy surface-to-air missile units that attempted over-centralized control from regional and national centers that had problems in compensating for the loss of a given center. The French built KARI (Iraq spelled backwards in French) system was designed to cover Baghdad, Basra, the northern oil fields, and Scud launching sites in the west, but left most of the country open, including the KTO. It also left Baghdad open to attacks that flew directly north from Saudi Arabia.[92]
- *Lack of armored maneuver warfare C^4:* Iraq had developed the ability to execute effective pre-planned armored attacks and counter-attacks during the Iran-Iraq War, and exploit them independently at the divisional level. It created a massive system of land lines and microwave communications in the KTO. It did not, however, have a mobile system capable of theater or corps level management of fluid armored battles, particularly in dealing with an enemy with equal or superior armored or air capability. Its land force C^4 systems could only manage maneuver warfare effectively in a climate of success.
- *Lack of war fighting training and doctrine:* In case after case, Iraq had never attempted to develop a pre-war doctrine and training capability to test the limitations of its system, to develop a doctrine for fighting an enemy with modern air and armored forces, and to training its officers at mid and high levels of command. Command post and field training exercises were infrequent, compartmented, and unrealistic.
- *Over reliance on physical security:* Iraq had many well sheltered facilities that were well protected with air defenses. It does not, however, seem to have had any realistic picture of their real world vulnerability to complex attacks. UN restraint in attacking civilian targets was often the only reason some major targets retained significant capability. It other, more exposed, cases the "protected" target was

Copyright Anthony H. Cordesman, all rights reserved

destroyed by systems like the F-111A "stealth" attack fighter using laser guided bombs.[93]

The problem that Iraq faced was not that its system did not work in peacetime, or that it had not met the needs of the Iran-Iraq War. It was that the Iraqi system was totally unsuited to defending against the kind of AirLand battle that the UN Coalition forced it to fight.

Copyright Anthony H. Cordesman, all rights reserved

Table 4.3

Iraqi Command and Control Centers and Related Facilities Involved in the Gulf War

Type	In Iraq			In Kuwait		Total	
	July, 1990	Jan, 1991	June, 1991	Jan, 1991	June 1991	Jan, 1991	June 1991
Command, Control and Communications							
Telecommunications	201	604	582	38	38	642	620
Offensive Air C2 19	20	19	1	1	21	20	
Air Defense HQ	24	152	127	2	0	154	127
Electronic Warfare	26	37	36	11	10	48	46
Surface-to-Surface Missile HQ							
National, Combined, Joint Commands 1	6	6	10	2	16	8	
Ground Force HQ	47	104	102	13	11	117	113
Naval HQ and Staff	3	3	2	1	1	4	3
Sub-total	321	926	874	76	63	1,002	937
Government Control							
Government Control Centers	15	52	50	1	1	53	51
Government Bodies	13	17	17	5	5	22	22
Non-military Ministries and Bodies	2	4	4			4	4
Unidentified		4	4			4	4
Government Trade/Commerce							
Civil Defense (Military)	1	2	2			2	2
Sub-total	31	79	77	6	6	85	83
Non-Communications Electronic Installations							
Radar installations							
Radar collocated with SAM sites							
ATC/Navigational aids							
Meteorological radars							
Sub-total	450	502	489	61	2	563	491
Total Command and Control Related	802	1,507	1,440	143	71	1,650	1,511

Note: This table does reflect a legitimate build-up in Iraq facilities, but it also represents the results of a massive US defense intelligence effort to find new targets. It is illustrative, and precise numbers cannot be derived from the available data. Blank spaces indicate either zero or data unknown. The source material does not permit a distinction.

Source: Adapted from the DIA automated files summarized in Eliot Cohen, ed., Gulf War Air Power Survey, Volume V Washington, GPO, 1993, pp. 217-219.

Copyright Anthony H. Cordesman, all rights reserved

Lessons For Coalition Warfare And International Peace Making: Desert Storm Versus Future Wars

There are obvious risks in generalizations about the lessons of the Gulf War for future coalition warfare and international peace making. Bosnia and Somalia have already provided grim lessons in the fact that the UN and member states will treat different conflicts very different, and that specific contingencies have specific needs. In fact, military history shows that victory is generally the result of adapting command and control to specific contingencies, rather than trying to impose existing or preplanned systems on reality.

As the previous analysis has shown, however, the success of the UN in Coalition in the Gulf War was critically dependent on a fundamental shift in the tempo and intensity of conflict, and the integration of maneuver, attrition, and support. These changes in warfare, in turn, were dependent upon:

- Having time in which to solve C^4 problems which no member of the Coalition could have dealt with without months of effort
- Resolving national roles and missions and clearly defining them in every aspect of command and operations
- Creating a unified co-located joint command
- Finding ways to establish *de facto* unity of command and control in key functions
- US ability to deploy a wide range of high technology command and control systems
- Providing friendly forces with the required range of equipment to use US systems and be interoperable with US forces

These factors are both lessons and a warning. There is often a tendency at the political level to assume military capability, rather than ensure it. As is true of virtually every aspect of Desert Storm, the fact that Iraq granted the Coalition more than five critical months in which to ensure military capability it did not have at the time of Iraq's invasion of Kuwait is a lesson that enemies can learn as well as friends.

The US is already changing many aspects of its C^4/BM systems to reflect the lessons of the Gulf War. A major effort is underway to make all aspects of the USAF, US Navy, and US Marine Corps air C^4I/BM system fully interoperable. The basic structure of the JFACC and ATO are being preserved, but the ATO process is being greatly accelerated and simplified for joint and coalition warfare, producing supporting communications, computer, and intelligence systems that will be more sophisticated, interoperable, and quick reacting.[94]

Copyright Anthony H. Cordesman, all rights reserved

However, resource problems are limiting the pace of these improvements, and the US still seems to lack any clear doctrine for providing packages of the necessary equipment to friendly forces, to help them develop an independent level of capability in terms of training, doctrine, and the acquisition of less capable equipment. Such resource, modernization, and organization problems are also far more serious in European forces, and in most of the major regional power the West might have to cooperate with in a new major regional conflict. This includes South Korea, Japan, and the Southern Gulf states.

One lesson is certain: Cooperative and coalition warfare cannot be fought using rhetoric and doctrine as substitutes for adequate C^4I/BM warfighting capability. At present, most forms of coalition warfare would mean at least several months of preparation to create interoperable and effective C^4I/BM systems for mid and high intensity coalition operations outside the areas where the core of such capabilities already exist. Further, creating such capabilities could be just as critical in low intensity contingencies where such capabilities would be critical to reducing coalition casualties and collateral damage, and executing complex politically-dominated battles or peace keeping efforts.

---

[1] The primary sources for the data in this chapter are interviews, official US histories of the Gulf War, and the memoirs of wartime commanders. Additional references are footnoted. Some other interesting summary publications include Larry Grossman, "Beyond Rivalry," Government Executive, June, 1991, pp. 10-14; James W. Canan, "How to Command in War," Air Force Magazine, April, 1991, pp. 14-21; Bruce Watson, et al, Military Lessons of the Gulf War, London, Greenhill Books, 1991; US News and World Report, Triumph Without Victory: The Unreported History of the Gulf War, New York, Times Books, 1992, Sterling Sessions and Carl R. Jones, Interoperability: A Desert Storm Case Study, McNair Paper 18; Fort McNair, National Defense University, July, 1993, and Shaun Gregory, Command, Control, Communications, and Intelligence in the Gulf War, Working Paper 238, Canberra, Strategic and Defense Studies Center, Australian National University, September, 1991; Bob Woodward's The Commanders; and Rick Atkinson's Crusade.

[2]Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, Annex K, p. K-24.

[3] The US. Army history of the war credits General Yeosock with this initiative. See Brigadier General Robert H. Scales, Certain Victory, Washington, US Army Chief of Staff, 1993, pp. 122, 381.

[4] Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, Annex K, pp. K-4 to K-9, K-25.

Copyright Anthony H. Cordesman, all rights reserved

[5] For a summary some of these developments, see Peter Grier, "The Data Weapon," Government Executive, June, 1992, pp. 20-24.

[6] Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, Annex K, pp. K-9 to K-11.

[7] Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, Annex K, pp. K-11 to K-13.

[8] Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, Annex K, pp. K-13 to K-16.

[9] Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, Annex K, pp. K-16 to K-18.

[10] Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, Annex K, pp. K-18 to K-20.

[11] For additional details about the creation and function of the C3IC, see Eliot Cohen, ed., Gulf War Air Power Survey, Volume I, Part II, Washington, GPO, 1993, pp. 45-48.

[12] A wide range of reports on the impact of command personalities, and national and service rivalries were examined during the writing of this report. There is no question that many incidents and tensions took place. At the same time, the reader is invited to examine the volumes on high command activity in the official war histories of World War II and Korea, or the memoirs of those involve in allied headquarters in Europe in World War II. Several useful sources that are sometimes cited for the level of tension they report are actually most interesting for the level of tension that they do not report -- although they often conflict in detail. Bob Woodward's The Commanders, and Rick Atkinson's Crusade, are particularly useful in this regard. The reader should also examine the relevant chapters of Lt. General H. Norman Schwarzkopf, It Doesn't Take a Hero, and General Sir Peter Billiere's Storm Command . A detailed description of the causes of some aspects of command friction, and one that indicates that many impressions of interservice and national rivalry had different causes is provided in Eliot Cohen, Gulf War Air Power Survey, Volume I, Part II. It is unfortunate that General Schwarzkopf's book seems to exaggerate problems with the Saudis and General Khalid Bin Sultan. General Khalid Bin Sultan's memoirs are still in draft, but for his comment on the Schwarzkopf book see General Khalid Bin Sultan, "Share the Credit General Schwarzkopf," Chicago Tribune, November 2, 1992, p. 1-23. Additional data on the personalities and role of Army commanders is summaries in "The Army Commanders," Army, March, 1991, pp. 49-54, and Brigadier General Robert H. Scales, Jr., Director, Certain Victory, pp. 58 and 222.

Copyright Anthony H. Cordesman, all rights reserved

[13] The US Central Command (USCENTCOM) grew out of the Southwest Asia area command in the US Readiness Command, which was formed in 1971, and the operation command created for the Rapid Deployment Joint Task Force in 1981-1983. Its headquarters was at MacDill Air Force base in Florida. The Army Component (ARCENT) headquarters was at Fort McPherson, Georgia. The Air Force Component (CENTAF) headquarters was at Shaw Air Force Base, South Carolina, the Navy Component (NAVCENT) headquarters was at Pearl Harbor, Hawaii, the Marine Component (MARCENT) headquarters was at Camp Pendelton, California, and the Special Operations Component (SOCCENT) was at MacDill Air Force base in Florida.

[14] Discussion of the RC-135V/W Rivet Joint aircraft is deliberately minimized in this analysis.

[15] For a detailed description of the JFACC see Thomas A. Keaney and Eliot A. Cohen, Gulf War Air Power Survey: Summary Report, Washington, Department of the Air Force, 1993, pp. 145-161, Eliot Cohen, ed., Gulf War Air Power Survey, Volume I, Part II, Washington, GPO, 1993, pp. 17-54, 143-233; and Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, pp. 123-125, 136-140, 228-231, 244-246, 253.

[16] For a more discussion of some of the strengths and weaknesses of the JFACC, including allied attitudes regarding its influence on unity of command, see Eliot Cohen, ed., Gulf War Air Power Survey, , Washington, GPO, 1993, draft summary of April 20, 1993, pp. 3-15, and the references in the footnote above.

[17] Eliot Cohen, ed., Gulf War Air Power Survey, Volume I, Part II, Washington, GPO, 1993, pp. 45.

[18] Eliot Cohen, ed., Gulf War Air Power Survey, Volume I, Part II, Washington, GPO, 1993, pp. 49.

[19] See Eliot Cohen, ed., Gulf War Air Power Survey, Volume I, Part II, Washington, GPO, 1993, pp. 77-126 (especially pp. 102-106), 132-144; and Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, pp. 137, 139, 146, 228.

[20] See Eliot Cohen, ed., Gulf War Air Power Survey, Volume I, Part II, Washington, GPO, 1993, pp. 109, 111, 113, 118-119, 122-125.

[21] See Eliot Cohen, ed., Gulf War Air Power Survey, Volume V, Part I, Washington, GPO, 1993, pp. 132-135, and Gulf War Air Power Survey, Volume I, Part II, Washington, GPO, 1993, pp. 61-72, 74, 77-83, 87, 89-90, 97, 99, 101, 106, 117-120, 131-150.

Copyright Anthony H. Cordesman, all rights reserved

[22] Eliot Cohen, ed., Gulf War Air Power Survey, Volume I, Part II, Washington, GPO, 1993, p. 74-75, 86-88; and examine the quality of doctrine provided in Tactical Air Command Regulation 55-45, Tactical Air Force Headquarters and TACC, April 8, 1988.

[23] Thomas A. Keaney and Eliot A. Cohen, Gulf War Air Power Survey: Summary Report, Washington, Department of the Air Force, 1993, pp. 128-132.

[24] There are a number of anecdotal discussions of the Special Planning Group. For a detailed analysis see Eliot Cohen, ed., Gulf War Air Power Survey, Volume I, Part II, Washington, GPO, 1993, pp. 77-126, 157-191. Also see Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, pp. 123-124, 137-138, Richard P. Hallion, Storm Over Iraq, Washington, Smithsonian, 1992, pp. 143, 169-170; and Michael R. Gordon and General Bernard E. Trainor, The General's War: The Inside Story of the Conflict in the Gulf, Boston, Little Brown, 1994, pp. 94-99.

[25] The most detailed "inside" discussion of these differences over the priority given to strategic bombing is contained in Michael R. Gordon and General Bernard E. Trainor, The General's War: The Inside Story of the Conflict in the Gulf, Boston, Little Brown, 1994. The discussion in this book, however, differs in some detail with other discussions of this issue, and with the author's interviews with several personalities involved.

[26] See Lt. General H. Norman Schwarzkopf, It Doesn't Take a Hero, p. 313; Eliot Cohen, ed., Gulf War Air Power Survey, Volume I, Part II, Washington, GPO, 1993, pp. 163.

[27] There are many conflicting appraisals of the role of Colonel Warden and the impact of "Instant Thunder". For a good sympathetic discussion of his role, and the resulting debates among senior commanders, see Michael R. Gordon and General Bernard E. Trainor, The General's War: The Inside Story of the Conflict in the Gulf, Boston, Little Brown, 1994, pp. 77-94. For an excellent neutral history of the effort, see Dianne T. Putney, "From Instant Thunder to Desert Storm," Air Power History, Fall, 1994, pp. 39-50, and the "Planing" section of Eliot Cohen, ed., Gulf War Air Power Survey, Volume I, Washington, GPO, 1993

[28] See Eliot Cohen, ed., Gulf War Air Power Survey, Volume I, Part II, Washington, GPO, 1993, pp. 170-186; and Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, pp. 123-124 and 137-138.

[29]Eliot Cohen, ed., Gulf War Air Power Survey, Volume I, Part II, Washington, GPO, 1993, pp. 170-186; and Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, pp. 136-141, 147, 180, 200, 228-233, 238, 246.

Copyright Anthony H. Cordesman, all rights reserved

[30] For additional details, including actual ATO plans, see Eliot Cohen, ed., Gulf War Air Power Survey, Volume I, Part II, Washington, GPO, 1993, especially pp. 144-154 and 191-205.

[31] Eliot Cohen, ed., Gulf War Air Power Survey, Volume I, Part II, Washington, GPO, 1993, pp. 191-201, 212, 216-217

[32] For a detailed discussion of these issues, see Eliot Cohen, ed., Gulf War Air Power Survey, Volume I, Part II, Washington, GPO, 1993, pp. 17-54, 143-233.

[33] Brigadier General Robert H. Scales, Certain Victory, p.188.

[34] For additional details, see Eliot Cohen, ed., Gulf War Air Power Survey, Volume I, Part II, Washington, GPO, 1993, especially pp. 41-42, 46-53, 55-60, 62-65, 69-75, 105-106, 131-132, 154-155, 184-186, 330-335, 358-363; Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, pp. 123, 136-141, 169, 185, 228-231, 244-246, 253, 297, and Richard P. Hallion, Storm Over Iraq, Washington, Smithsonian, 1992, pp. 109-110, 136, 141-142.

[35] For additional details on the ATO, including actual ATO plans, see Eliot Cohen, ed., Gulf War Air Power Survey, Volume I, Part II, Washington, GPO, 1993, pp. 69-71, 95-96, 100-101, 115-117, 144-154, 163-168, and 191-205.(especially pp. 144-154 and 191-205); Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, pp. 136-141, 147, 180, 200, 228-233, 238, 246, and Richard P. Hallion, Storm Over Iraq, Washington, Smithsonian, 1992, pp. 143, 155, 256, 258.

[36] Inside the Navy, July 12, 1993, p. 6.

[37] Eliot Cohen, ed., Gulf War Air Power Survey, Volume I, Part II, Washington, GPO, 1993, pp. 209-227, 230-234.

[38] Based on interviews with US Air Force and US Navy analysts, and Eliot Cohen, ed., Gulf War Air Power Survey, Volume I, Part II, Washington, GPO, 1993, pp. 257-260.

[39] Eliot Cohen, ed., Gulf War Air Power Survey, Volume V, Washington, GPO, 1993, pp. 133-135.

[40] Colonel Randy Witt (ed.), Air Force Tactical Communications in War: The Desert Shield/Desert Storm Communications Story, HQ, USCENTCOM Air Forces, Riyadh, Saudi Arabia, March, 1991, pp. 1-12. Eliot Cohen, ed., Gulf War Air Power Survey, Volume V, Washington, GPO, 1993, pp. 133-135.

[41] Desert Storm started with 2,430 fixed wing aircraft and grew to over 2,700. About 60% of these aircraft were "shooters". For key sources on this section see Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, pp. 136-140 and Annex K; Eliot Cohen, ed., Gulf War Air Power Survey, Volume I,

Copyright Anthony H. Cordesman, all rights reserved

Part II, Washington, GPO, 1993, pp. 46-53, 55-60, 62-67, 154-155, 184-195, 330-335, 362-368.

[42] Data bases differ. USAF briefing papers report 448 sorties, and Eliot Cohen, ed., Gulf War Air Power Survey, Volume V, Part I, Washington, GPO, 1993, pp. 370 reports 379.

[43] Eliot Cohen, ed., Gulf War Air Power Survey, Volume V, Part I, Washington, GPO, 1993, pp. 317 and 370. A total of 218 of the Saudi sorties are reported as refueling sorties and 85 C^3 sorties, but most of the Saudi sorties had a C^3 function.

[44] For a detailed description of Saudi AWACS activity see Eliot Cohen, ed., Gulf War Air Power Survey, Volume I, Part II, Washington, GPO, 1993, pp. 92-95.

[45] Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, pp. 148, T-36-43;

[46] Available data bases do not clearly distinguish between those sorties clearly related to ABCCC functions, but these only include USAF EC-130s. Special forces units flew another 68 sorties in special forces missions, 84 in electronic warfare missions, and 3 in other missions. Eliot Cohen, ed., Gulf War Air Power Survey, Volume V, Part I, Washington, GPO, 1993, p. 374.

[47] Federal Computer Week, March 7, 1994, p. 14.

[48] Eliot Cohen, ed., Gulf War Air Power Survey, Volume I, Part II, Washington, GPO, 1993, p. 84; Eliot Cohen, ed., Gulf War Air Power Survey, Volume V, Part I, Washington, GPO, 1993, p. 364.

[49] For additional details see Peter Grier, Joint Stars Does Its Stuff," Air Force Magazine, June, 1991, pp. 38-42, and Aviation Week, March 11, 1991, p. 20.

[50] Eliot Cohen, ed., Gulf War Air Power Survey, Volume I, Part II, Washington, GPO, 1993, pp. 49-60.

[51] Inside the Navy, July 12, 1993, p. 6.

[52] Inside the Navy, July 12, 1993, p. 6.

[53] See the arguments for this position in Lt. General Royal N. Moore, "Marine Air: There When Needed," Proceedings, November, 1991, pp. 63, and Major W. R. Cronin, "C^3I During the Air War in South Kuwait," Marine Corps Gazette, March, 1992, p. 35.

[54] Michael R. Gordon and General Bernard E. Trainor, The General's War: The Inside Story of the Conflict in the Gulf, Boston, Little Brown, 1994, pp. 73-74, 77-94, 143-147, 160, 165-169, 174-176, 299-309, 318-322, 395-397.

[55] Eliot Cohen, ed., Gulf War Air Power Survey, Volume I, Part II, Washington, GPO, 1993, pp. 59-60, 64, and interviews with US Army officers.

Copyright Anthony H. Cordesman, all rights reserved

[56] Lt. General Royal N. Moore, "Marine Air: There When Needed," Proceedings, November, 1991, pp. 64

[57] For detailed background and discussion of these issues, see Jeffrey E. Stambaugh, "JFACC: Key to Organizing Your Air Assets for Victory," Parameters, Summer, 1994, pp. 98-110; Dwight R. Motz, "The JFACC: The Joint Air Control Cold War Continues," Marine Corps Gazette, January, 1993; Price T. Bingham, Ground Maneuver and Air Interdiction in the Operational Art, Maxwell Air Force Base, Air University Press, 1992; Duane A. Wills, "Break Some Rice Bowls," Proceedings, November, 1991; John E. Valliere, "Stop Quibbling and Win the War," Proceedings, December, 1990; Richard P. Hallion, Storm Over Iraq, pp. 189-90, 206-208; Joint Chiefs of Staff, Joint Publication 3-56, Command and Control for Joint Operations, September, 1992, Section IV; USAF, Deputy Chief of Staff, Plans and Operations, JFACC Primer, August, 1992.

[58] For a discussion of how air command in the Gulf has changed since the Gulf War, see Michael A. Nelson and Douglas Katz, "Unity of Control: Joint Air Operations in the Gulf," Joint Forces Quarterly, Summer, 1994, pp. 59-70.

[59] There are a number of "insider" discussions of these issues, all of which are controversial and uncertain. The best to date seems to be Michael R. Gordon and General Bernard E. Trainor, The General's War: The Inside Story of the Conflict in the Gulf, Boston, Little Brown, 1994, pp. .

[60] Richard P. Hallion, Storm Over Iraq, pp. 143, 155, 256, 258; General Sir Peter Billiere, Storm Command, pp. 205-206; Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, pp. 148, K-49; Eliot Cohen, ed., Gulf War Air Power Survey, Volume I, Part II, Washington, GPO, 1993, pp. 17-54, 143-233.

[61] Rear Admiral John Scott Reid, Deputy Chief of Naval Operations for Plans, Policies, and Operations, "Statement Before the Senate Army Services Committee on Lessons of the Gulf War," April 18, 1994, p 4.

[62] Raoul Henry Alcala, "Guiding Principles for Revolution, Evolution, and Continuity in Military Affairs, Carlisle Barracks, US Army War College, April, 1994, pp. 15-16; Rear Admiral John Scott Reid, Deputy Chief of Naval Operations for Plans, Policies, and Operations, "Statement Before the Senate Army Services Committee on Lessons of the Gulf War," April 18, 1994, p 7; Bernard E. Trainor, "Jointness, Service Culture, and the Gulf War," Joint Force Quarterly, Winter 1993-1994, p. 71; Inside the Navy, July 12, 1993, p. 6.

[63]For background, see the comments by Admiral William Owens, Vice Chairman of the US Joint Chiefs, in Defense News, June 6, 1994, p. 1

Copyright Anthony H. Cordesman, all rights reserved

[64] Dr. Edward L. Warner, III, Assistant Secretary of Defense (Strategy and Requirements), "Statement Before the Senate Army Services Committee on Lessons of the Gulf War," April 18, 1994, p 6.

[65] For a good overview of current US concepts regarding jointness, see Joint Doctrine: Capstone and Keystone Primer, Washington, Office of the Joint Chiefs of Staff, July 15, 1994.

[66] US Defense Science Board, Lessons Learned During Operation Desert Storm, p. 61 as quoted in Eliot Cohen, ed., Gulf War Air Power Survey, Volume I, Part II, Washington, GPO, 1993, p. 263.

[67] Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, Annex K, p. K-26, K-28.

[68] Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, Annex K, p. K-26, K-28.

[69] A reading of unit histories and command memoirs reveals constant problems with some aspect of communications, command systems, or intelligence dissemination. Such problems were particularly common, for example, in some aspects of communications between VII Corps and C3IC, and within the 1 (US) MEF. These problems helped contribute to the IFF problem that caused a number of Coalition casualties. What is generally missing is the kind of critical command system or communications breakdown common in previous wars, even in Vietnam, that often produced high casualties in a given battle or encounter.

[70] Thomas A. Keaney and Eliot A. Cohen, Gulf War Air Power Survey: Summary Report, Washington, Department of the Air Force, 1993, pp. 231-232.

[71] Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, Annex K, pp. T-221 to T-225; Colonel Randy Witt (ed.), Air Force Tactical Communications in War: The Desert Shield/Desert Storm Communications Story, HQ, USCENTCOM Air Forces, Riyadh, Saudi Arabia, March, 1991; Eliot Cohen, ed., Gulf War Air Power Survey, Volume V, Washington, GPO, 1993, pp. 133-134.

[72] Testimony by General Donald J. Kutyna, CINC US Space Command before the Senate Armed Services Committee on April 23, 1991, p. 34.

[73] See the description of the impact of such systems in Space News, October 14, 1991, p. 1.

[74] Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, Annex K, pp. K-28, K-30, K-45.

[75] See Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, Annex K, pp. KK-28-47.

Copyright Anthony H. Cordesman, all rights reserved

[76] Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, Annex K, pp. K-37-38.

[77] The VRC-12 system has failed to meet US tactical needs, even in minor low intensity warfare training exercises, for more than a decade. The author has seen repeated problems with this system. Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, Annex K, pp. K-37-38.

[78] Amphibious Warfare Review, Summer/Fall, 1994, p. 49.

[79] Defense News, April 18-24, 1994.

[80] For a good summary of views on this issue see Major General Wesley K. Clark, "Digitization: Key to Landpower Dominance," Army, November, 1993, pp. 28-33; General Jimmy D. Ross, "Winning the Information War," Army, February 1994, pp. 27-32; Lt. General Paul E. Funk, "The Army's Digital; Revolution," Army, February, 1994, p. 33; and Major General William H. Campbell, "NTC to Test Digitization, Army, February, 1994, p. 34, and Lt. Colonel Thomas W. Mastaglio and Lt. Colonel Thomas R. Rozman, "Expanding Training Horizons," Army, February, 1994, pp. 39. Also see Aviation Week, February 21, 1994, p. 90. Initial tests of these concepts had had mixed results, but there is little doubt regarding their potential value.

[81] Richard P. Hallion, Storm Over Iraq, p. 314; Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, pp. T-219-221.

[82] For discussions of the importance of weather see General Sir Peter Billiere, Storm Command, pp. 216-217,224-225, 236,268, 288; Richard P. Hallion, Storm Over Iraq, pp. 176-177, 231, 234-235, 237; Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, p. 196; Eliot Cohen, ed., Gulf War Air Power Survey, Volume IV, Washington, GPO, 1993, pp. 14, 19, 42-45, 62-65, 117-121, 148-156, 161-162, 226-228, 266-274, and draft summary of March 27, 1993, pp. 7-9.

[83] See Eliot Cohen, ed., Gulf War Air Power Survey, Volume IV Washington, GPO, 1993, pp. 47-48, 78, 80, 118-120, 160, 203-204, 225, 248, 286; Department of Defense, Conduct of the Persian Gulf War: Final Report, Department of Defense, April, 1992, Annex K, pp. T-225-227; testimony by General Donald J. Kutyna, CINC US Space Command before the Senate Armed Services Committee on April 23, 1991, pp. 20-23.

[84] See George Marsh, "Wishing on a NAVSTAR," Defense Helicopter, August-September, 1991, pp. 37-38.

[85] Satellite accuracy and user dynamics often cause far lower accuracies, and can cause the potential loss of altitude data in some areas. Eliot Cohen, ed., Gulf War Air Power Survey, Volume V, Washington, GPO, 1993, p. 131.

Copyright Anthony H. Cordesman, all rights reserved

[86] For civil arguments against such degradation of the GPS, see Space News, April 29, 1991, p. 3.

[87] Eliot Cohen, ed., Gulf War Air Power Survey, Volume II Washington, GPO, 1993, pp. 240-241, 277-278.

[88] Eliot Cohen, ed., Gulf War Air Power Survey, Volume I Washington, GPO, 1993, p. 216.

[89] Some of the early reporting on the war greatly exaggerated the effectiveness of UN efforts. For an accurate post-action analysis, see Eliot Cohen, ed., Gulf War Air Power Survey, Volume II Washington, GPO, 1993, pp. 240-247, 274-290.

[90] Rick Atkinson, Crusade, pp. 438-439.

[91] Russian observations of the war do not, however, reflect any consensus, and often seem more the product of special pleading to influence internal Russian debates than objective analysis. See Mary C. Fitzgerald, "The Soviet Image of Future War: 'Through the Prism of the Persian Gulf'," Comparative Strategy, October-December, 1991, pp. 393-424; Captain Brian Collins, "Soviet View of the Storm," Air Force, July, 1992, pp. 70-74; Captain David P. Dilegge, "Soviet Lessons Learned: Operation Desert Storm, Marine Corps Gazette, February, 1992, pp. 38-40.

[92] Eliot Cohen, ed., Gulf War Air Power Survey, Volume II Washington, GPO, 1993, p. 81.

[93] The much publicized GBU-28 hard target penetrator was used against bunker type targets, but only two were ever used and then on the last night of the war. One missed, but the other did penetrate the bunker. Eliot Cohen, ed., Gulf War Air Power Survey, Volume II Washington, GPO, 1993, pp. 240-241.

[94] This discussion draws on Dr. Edward L. Warner, "Statement Before the Subcommittee on Military Readiness and Defense Infrastructure of the Senate Armed Services Committee," Office of the Assistant Secretary of Defense (Strategy and Requirements, April 18, 1994, p. 4; Major General Larry L. Henry, "Statement Before the Subcommittee on Military Readiness and Defense Infrastructure of the Senate Armed Services Committee," US Air Force, Staff for Plans and Operations, April 18, 1994; Lt. General Norman E. Ehlert, "Statement Before the Subcommittee on Military Readiness and Defense Infrastructure of the Senate Armed Services Committee," US Marine Corps, Staff for Plans, Policies, and Operations, April 18, 1994.

Copyright Anthony H. Cordesman, all rights reserved