New Horizons

Coalition Space Operations

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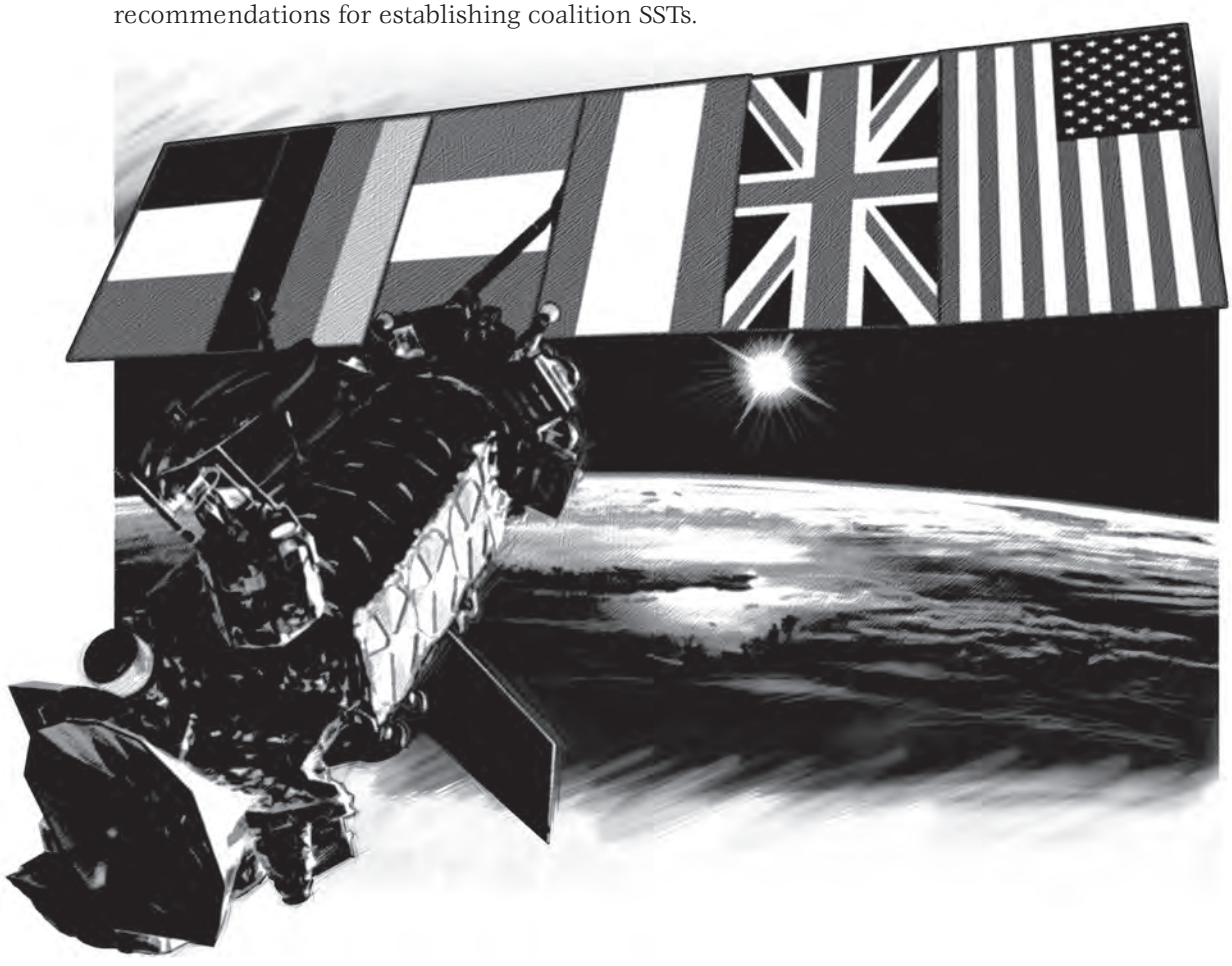
To provide a current picture of space power in the North Atlantic Treaty Organization (NATO), in January 2009 the Joint Air Power Competence Centre published *NATO Space Operations Assessment*, which recommends 23 ways to improve NATO's integration of space into military operations.[1] The NATO-led International Security Assistance Force (ISAF) in Afghanistan, which faces significant challenges, exemplifies the need to conduct coalition space operations. Performing combined and joint air, land, sea, and special operations, the ISAF finds itself in the early stages of integrating national space capabilities, critical enablers to operations that require the leveraging of all available resources. One means of integration involves establishing coalition space support teams (SST), but in order to conduct space operations with these teams, we must address matters of doctrine, presentation of forces, education, training, and equipment. This article offers some thoughts and recommendations for establishing coalition SSTs.



Historical Perspective

Operation Desert Storm is generally accepted as the first space war even though the military developed and used space capabilities long before that conflict.[2] To put these capabilities into historical perspective, we need to go back to Vietnam and the Cold War. For example, Corona, the United States' first photo reconnaissance satellite system, operated from August 1960 to May 1972.[3] Also in 1960, the US Navy tested the five-satellite Transit, the first satellite navigation system, which could generate a navigational fix four to six times a day.[4] The first Missile Defense Alarm System satellite, designed to serve as a space-based early warning system for ballistic missile launches from the Soviet Union, became operational in 1963.[5] Following that system was the Defense Support Program, developed to detect missile or spacecraft launches and nuclear explosions by picking up infrared emissions. The Defense Meteorological Satellite Program began providing cloud-cover information in the mid-1960s, allowing more precise planning of air missions in Vietnam.[6] In 1970 the United States launched its first signals intelligence satellite.[7] The more commonly known global positioning system first launched in 1978, reaching initial operational capability in 1993.[8] Even though the United States has operated these and other satellites for more than 50 years, only recently did we fully integrate their capabilities into combat operations.

Allied Space Capabilities

Our coalition partners can now employ a variety of space assets. France became the third recognized space power, after the Soviet Union and the United States, when it launched its first satellite in 1965.[9] The French now operate satellites for communications, electro-optical, infrared, signals intelligence, and electronic intelligence; they should field an early warning system by 2020.[10] Italy and Germany have also become players in the space defense sector, Italy launching its first communications satellite in 2001 and the first of four synthetic aperture radar (SAR) satellites in 2007.[11] Germany launched a constellation of six SAR satellites from 2006 to 2008 and will add another in 2010; moreover, it launched five medium-resolution electro-optical satellites in 2008.[12] The Germans have also developed two communications satellites, one on orbit and the other scheduled for launch in 2010.[13] Other military satellite communications (SATCOM) programs in Europe include the United Kingdom's Skynet and Spain's Hisdesat satellites. The European Union's Galileo program will provide a global positioning, navigation, and timing (PNT) capability. Clearly, the Europeans have much to offer.

In addition to technology and hardware, our coalition partners offer trained space personnel. Many nations have studied our space doctrine and are quickly catching up. The French have set a goal of fostering a military space culture across the European Union. A French Joint Space Command will likely stand up in the summer of 2010—a major step forward.[14] In 2008 Germany announced that it would establish a Space Situational Awareness Center in Uedem, Germany.[15] The Royal Air Force has a Space Operations Coordination Centre in High Wycombe.[16] Spain placed a European Union Satellite Centre in Torrejón.[17] As the space capabilities of European nations continue to grow, the expertise of those countries will develop. Additionally, other states such as Japan, India, and Australia are acquiring their own space capabilities. Integration of such allied resources could allow the rapid reconstitution of lost capability, add capability, decrease revisit times, and so on. Al-

lied space personnel offer strength through diversity by bringing to the table a different cultural perspective. Experts in their space systems and organizations, they have different understandings of and solutions to the geopolitical environment. Although the United States would greatly benefit from increased partnerships with the growing number of space personnel, this relationship will demand changes to the way we currently operate.

Why a Coalition Team?

Coalition operations are not new. Nations formed alliances to fight the two world wars, Korea, Vietnam, the Balkans, Iraq, and Afghanistan. War fighters in US Central Command's area of operations conduct joint and combined operations. Nations such as Afghanistan, Australia, Belgium, Canada, Germany, Iraq, Italy, France, the Netherlands, and the United Kingdom all participate in flying operations with the United States. In addition to providing international political support and sharing risks, resources, and costs, a coalition establishes legitimacy in the international community. A complex undertaking, modern warfare includes diplomatic, political, social, economic, informational, and military aspects, not to mention staggering costs that few nations can afford for an extended time. Our economies and governments have become inexorably intertwined in the international arena. Most importantly, sending troops afield requires political support both at home and abroad. The benefits of common security concerns, the dialogue and cooperation essential to a coalition, and the shared culture and understanding greatly outweigh any day-to-day challenges. Undoubtedly, nations will continue to organize themselves in coalitions to wage war.

Unfortunately, NATO, the ISAF, and most nations have neither adequately addressed space as a domain nor fully leveraged space capabilities. Coalition forces need space-based intelligence, surveillance and reconnaissance (ISR), SATCOM, global PNT, tracking of friendly forces, space control, environmental (weather) monitoring, and missile-warning capabilities. Generally speaking, these space capabilities emerged because of their cost-effectiveness or because the high ground of space represented the only feasible place for their employment. Current coalition operations require vast amounts of communications, imagery, intelligence, and information, which partner nations must share. The NATO-led ISAF in Afghanistan faces challenges because the sharing of intelligence and information cannot always occur at a common classified or unclassified level. Procedures for requesting, tasking, processing, exploiting, and disseminating intelligence are difficult at best. Problems arise with regard to technology as well as policy, data management, and sharing. We must use all of our available resources optimally because the ISAF can greatly benefit from space capabilities. Informational seams, such as the inability to share a critical piece of intelligence, reduce our operational effectiveness. Arguably our operational paradigm must change in the space community. Because we fight as a coalition team, we must include space. Products and services classified Top Secret just a few years ago are now unclassified and available from commercial companies. Therefore, we should take a critical step towards overcoming these challenges by integrating the space capabilities of our coalition partners.

The evolution of space integration in the United States can serve as a model for developing coalition space operations. As the United States cultivated space capabilities, it had to address integration, policy, doctrine, and the development of trained personnel. Doctrine has evolved over the years, training courses have emerged and changed, and a space career field has appeared. The United States now has a space cadre with combat experience in Iraq and Afghanistan—a cadre mature enough to include general officers who have spent most of their careers in space assignments. Pre-

senting forces, which remains a topic of debate between the Air Force and Army, will continue to adapt as America involves itself in coalition operations. As other nations and organizations, such as NATO, begin to think about space capabilities, they must consider how they can develop space forces and integrate them into coalition operations. Other nations can use the US space-integration construct to build a force structure that can conduct space operations within a coalition.

Training and Doctrine

The most difficult problem the Air Forces faces in integrating space is how to create an air and space officer to employ an air and space force.

—Lt Col Mark P. Jelonek,
Toward an Air and Space Force, 1999

Having space systems does not necessarily mean that our war fighters are using them; rather, we must integrate system capabilities into the fight. To develop a coalition's space capability, we would do well to learn lessons from the evolution of US space training and doctrine. For many years, the United States struggled to integrate and fully exploit highly classified and compartmented space systems. One solution entailed the establishment of space teams, much like coalition SSTs. US Space Command's joint SSTs, established in the mid-1990s, and their associated component SSTs served theater commanders and joint task forces, making space capabilities understandable and useful for warfare.[18] In 1995 the Air Force formed the 76th Space Operations Squadron to assist air component commanders' understanding and application of space capabilities in support of air operations.[19] These Air Force SSTs, designed to support the air operations center (AOC) and the tactical level of war, deployed to assist in Operations Joint Endeavor, Deny Flight, Desert Fox, Desert Thunder, and Allied Force.[20]

The United States possessed significant space capabilities, but Desert Storm taught senior leaders that we had not fully leveraged them. This situation led to formation in 1994 of the Space Tactics School, which became the US Air Force Weapons School's Space Weapons Instructor Course in 1996.[21] The course has produced 215 graduates, eight of whom have now reached the rank of colonel.[22] These space weapons officers, who assisted regional combatant commanders and became part of the AOCs, supported the joint force air component commander (JFACC) by providing space expertise and effects. Their success showed the Air Force the value of such embedded expertise.

By the end of 2000, the Air Force had begun to integrate space personnel throughout the combat air forces and ended the joint and Air Force SSTs. More recently the service established a position for the director of space forces, who advises the combined force air component commander and coordinates space requirements and effects for the theater. As part of the commander's staff, the director must rely on the embedded space operators in the various AOC divisions and throughout the area of operations to gather requests for effects and to integrate space into daily operations. This method has proven effective for operations in US Central Command; however, the Army has not adopted the director's doctrinal construct and continues to field SSTs. The Navy and Marine Corps have a small number of personnel with specialized expertise in space operations, but neither service fields space teams.

Primarily, the Army integrates space by means of its SST and the space support element (SSE), the former a deployable team of six Soldiers and the latter a smaller cell of typically two or three personnel assigned to a brigade or division headquarters.[23] Army SSTs began deploying in 1995 to make space a part of ground operations.[24] In 1998 the Army established Functional Area 40 (FA-40) (a space operations officer) as a mechanism for training and developing space specialists.[25] Both the Army SST and

SSE are responsible for coordinating space activities and synchronizing space mission-area activities throughout the operations and planning processes.

These teams and elements, which have proven successful in Iraq and Afghanistan, continue their high deployment and operations tempo. Embedding such space expertise in the combined joint task force (CJTF) structure ensures that space capabilities and effects are part of planning and that they support operations. Unfortunately, very few Air Force personnel have deployed to integrate space into ground operations. The service must do a better job of placing these individuals with units that use space-based services. A more joint approach would allow our forces to understand and make optimal use of space capabilities.

In terms of space, the fundamental doctrinal difference between the Air Force and Army is that the Air Force is primarily a *provider* of capabilities while the Army is primarily a *user*. Coalition operations require both providers and users. The Air Force established positions to command, control, and integrate space, whereas the Army fielded teams to exploit and utilize space-based services. For example, to improve air-land integration, the Air Force embeds air liaison officers and tactical control parties—experts on employing airpower—with Army forces. They coordinate communications and aircraft for precision air strikes. However, the Air Force has yet to establish space-operations liaison officers for the purpose of integrating its space capabilities into ground operations. As we look to the future of conducting combined space planning and operations, we must examine and modify US space-integration models in order to effectively include not only our other services but also those of our allies.

It is important to understand established space doctrine and to determine if we must adapt it to guide the conduct of coalition space operations. The United States has the most developed space doctrine of any NATO nation, having updated its joint space doctrine in 2009, Air Force doctrine in 2006, and Army doctrine in 2005, as well as having implemented Navy space policy in 2005.[26] NATO has been active as well, publishing its doctrine document for air and space operations in 2009.[27] The European Union published a space policy in 2007.[28] Australia, Great Britain, Holland, France, Germany, and other nations are developing or have recently established national space policy and doctrine. Unfortunately, no country has adequately captured the space-related realities of coalition operations in Afghanistan. An examination of questions about why US doctrine would have to change to support coalition space operations lies beyond the scope of this article, but we should address a few key points to understand what we need for coalition space teams. As other nations produce space capabilities, personnel, and centers, US doctrine will have to address the construct of those relationships and the means of interacting with them. For example, because the French now field a space team of three personnel to support their rapid-reaction forces and AOCs, we need to think in terms of developing a common framework, definitions, and mission areas.[29] The following discussion addresses concepts for establishing a foundation for coalition space operations.

Current US and NATO space-mission areas include *space-force enhancement*, *space control*, *space support*, and *force application*.[30] These terms have been in use for some years now and need revising (except for *space support*, which is still applicable). No longer simply an enhancement of our operations, space has become a critical joint enabler. Space control is often confused with offensive counteroperations, which aim to dominate enemy airspace and prevent the launch of air threats. The latter can include destroying the enemy's air and surface-to-air forces, interdicting his air operations, protecting air lines of communications, and establishing local military superiority in air operations.[31] Additionally, other nations consider the term *space control* much too aggressive and offensive in light of the intended peaceful use of space. No

Table 1. Proposed mission areas for space operations

Joint Support Space Operations*	*Counterspace Operations*	*Space Support Operations*
Position, Navigation, and Timing	Space Situational Awareness	Launch and Range Operations
Satellite Communications	Offensive Counterspace	Satellite Operations
Intelligence, Surveillance, and Reconnaissance	Defensive Counterspace	Command and Control of Space Forces
Missile Warning		Operational Test and Evaluation
Environmental Monitoring		Space Professional Development
Integration and Exploitation		

*The NATO term *joint* equates to the US term *combined*.

country wants to see US forces controlling space. Similarly, other nations find the term *force application*, which translates to weaponizing space, too politically sensitive and therefore unnecessary. The force-application mission makes other nations suspect that the United States has secretly placed weapons in space; otherwise, why would we have doctrine for weapons that don't exist? Since those countries study our doctrine, we need to be careful about the message it sends.

We need a new construct for US and NATO space-mission areas, including joint support space operations, counterspace operations, and space support operations (table 1). This construct would make the space-mission areas easier to understand and more accurately reflect actual operations. For example, joint support space operations would include PNT, SATCOM, ISR, missile warning, and environmental monitoring because they all directly support joint force operations. We should add one area not currently included in force enhancement—integration and exploitation. Some existing cross-functional programs in the space portfolio do not fit under a specific capability area. Additionally, the absence of integration and exploitation in the doctrine compromises any advocacy for funding or programs that we need most—specifically, those that use space capabilities to support the joint war fighter. As discussed above, coalition space doctrine should not mention *space control*; *counterspace* is a better term. Finally, we need add only *space professional development* to *space support operations* and omit *force application*, as mentioned above.

Drawing on these proposed mission areas, we can envision a notional structure for a coalition space team (table 2). Sized appropriately for the assigned mission, teams would have expertise in ISR, PNT, SATCOM, missile warning, space situational awareness, offensive counterspace, and defensive counterspace. Army SSTs and SSEs have benefited from training and deploying as integral units. Attempting to make these teams multinational presents certain challenges in terms of organizing, training, and equipping forces.

Table 2. Composition of a typical space team

Position	*Rank*
Space Coordination Element	
Senior Space Operations Planner	O-5
Space Operations Planner	O-4
Space Support Team	
Space Team Leader	O-4
Operations Officer	O-3
Counterspace Operations Planner	O-3 or E-6
Space Operations Planner	O-3 or E-6
Intelligence Analyst	E-6
Information Systems Operator	E-5
Space Support Element	
Senior Space Operations Officer	O-4
Space Operations Officer	O-3

Presentation of Forces

Using the proposed mission areas, we have to consider how the United States should present its space forces in-theater. Current US doctrine has Air Force personnel embedded in AOCs. The Army's SSEs are an integral part of its divisions, and Army SSTs deploy to augment CJTFs when needed. NATO doctrine addresses space operations only at a high level and does not offer guidance on presenting space capabilities or forces.[32] Furthermore, US joint doctrine only briefly addresses space in multinational operations.[33] Since the beginning of operations in Afghanistan, we have had no strategic plan to integrate space personnel, but the ISAF is developing an architecture to make better use of space capabilities. At the NATO joint level, two space officers are assigned to the ISAF Joint Command, including the chief of ISAF space operations—the force's senior space officer. At the regional level (which corresponds to the service-component level in US doctrine), Army SSTs are assigned to ISAF Regional Commands East and South headquarters. US Marines in Regional Command Southwest also have an assigned Army SST. Additional space personnel have been requested to support Regional Commands North and West. Unfortunately, the ad hoc nature of requests for space personnel over the past eight years has resulted in confusing command relationships and, for some, organizations lacking individuals with space expertise.

Our experience in Afghanistan recommends the following two-phased construct for integrating space into a multinational CJTF. Space must first find representation at the US joint level, in J-3 (operations) and J-5 (plans). Additionally, assuming the presence of a JFACC, we must continue to integrate space into the AOC because of the center's status as the command and control, planning, and execution node for air operations. The JFACC, also typically the commander of Air Force forces (COMAFFOR), should have space officers in A-3 (operations) and A-5 (plans). We can continue the current US Army structure for integrating space teams into land forces.[34] Each component command (and regional command in the ISAF) should have a coalition SSE at headquarters. Subordinate headquarters at the corps level would have a coalition SST. Since each service brings its own expertise and capabilities, the space teams/elements need joint manning. It is important to note that the number of teams and personnel depends on mission requirements and operations tempo. Team size and composition should be scalable to meet operational needs. For example, perhaps only a single space officer, rather than a full space team, would suffice for coordination.

The second phase will call for integrating coalition partners (fig. 1). Team integrity, training, and access to classified information must become a consideration, and higher headquarters will include multinational personnel. The tactical level is the most difficult place to integrate such personnel because they require detailed operational and system knowledge to perform their mission. Because formation of a multinational SSE or SST would prove difficult, this article recommends assignment of a national SSE to support its country's forces. Some of the teams could be multinational, depending on bilateral or multilateral security arrangements. We must also address assigned space units, which fall under the COMAFFOR as expeditionary space operations squadrons. Even so, they could be assigned to other commanders or components. Due to the political and strategic nature of space assets, these units would most likely have to report directly to their national authorities for guidance regarding rules of engagement. The command relationships would be developed, based on national direction and the mission. For the most part, we have integrated mature space capabilities into daily operations and have normalized them. Intelligence teams plan and execute the use of space-based ISR assets, and the communications team runs SATCOM. However, we still need some space specialists in strategic-

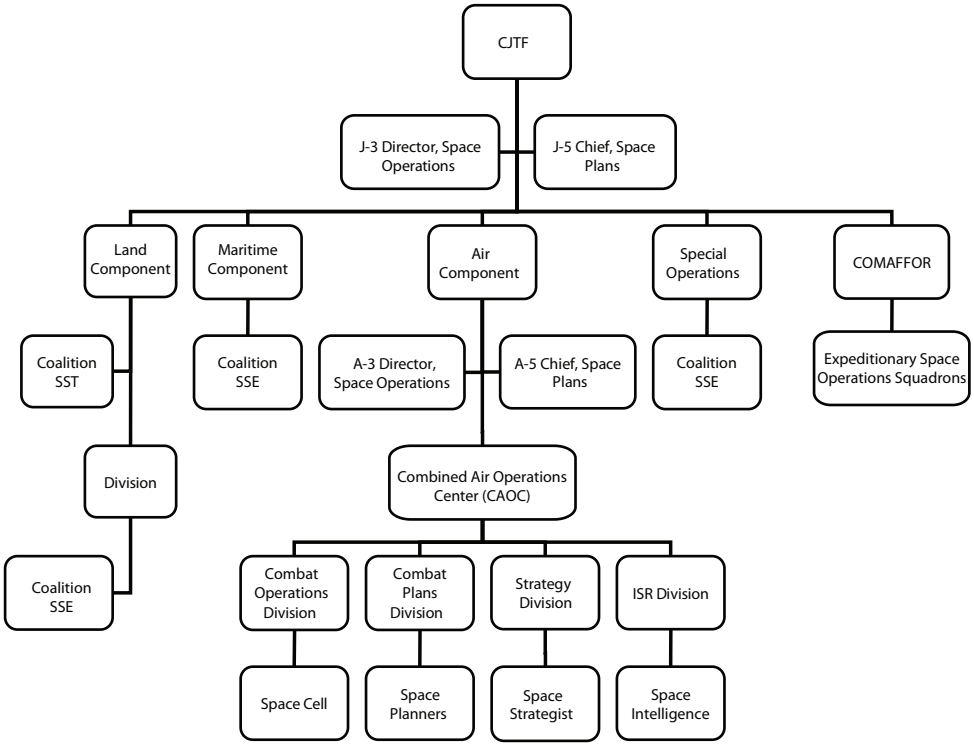


Figure 1. Structure of a notional combined joint task force

and operational-level positions. Consequently, this example does not require a director of space forces because of the full assimilation of space positions into the command structure.[35]

Space Support and Reachback

Soon after the start of the Schriever V war game of 2009, it became apparent that an integrated force structure would facilitate coordination for coalition operations.[36] This realization led to establishment of a CJTF-like organization and a combined space operations center construct. Building on this concept, we can think of designing a notional space support architecture for a coalition (fig. 2).

CJTF space forces must integrate effects and support the mission, perhaps via reachback to a space operations coordination center (SpOCC). Typically, the CJTF commander will designate a single focal point for space—logically, the JFACC and combat air operations center (CAOC). As the supported multinational command, the CAOC would enjoy direct support from the coalition SpOCC, which can serve as a virtual coordination center since a designated lead nation's SpOCC would become the coalition center. National SpOCCs can also directly support the coalition SpOCC. It would be wise for the CAOC to have arrangements with national SpOCCs for time-critical support. National space teams would have reachback via national command authorities and support channels. For example, space personnel supporting operations in US Central Command go the CAOC, which can then reach back to US Strategic Com-

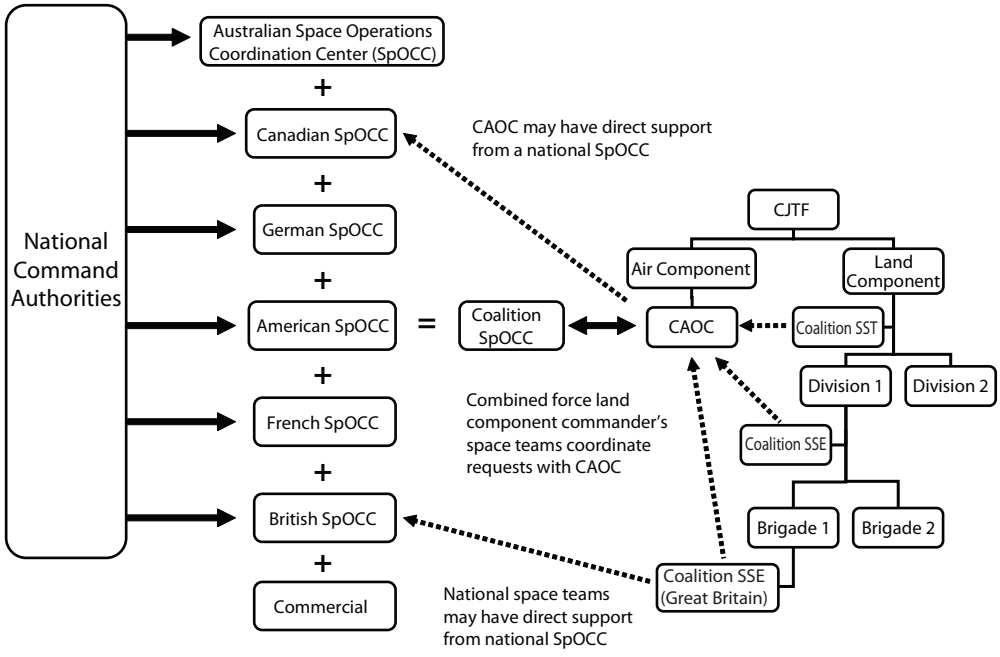


Figure 2. Notional space support architecture

mand's joint functional component commander for space and the joint space operations center.

Coalition operations require some nations to provide space capability, often both military and commercial satellite services. Consequently, each national SpOCC would have to maintain its own space picture and share some of that data with the coalition SpOCC to generate an integrated picture. Each SpOCC could serve as a central point of contact to access national space capabilities. National command authorities would maintain control of their national assets while providing an agreed-upon space capability or service to coalition operations. Doing so requires that we put in place agreements today to begin developing guidance for security classification, interoperable information networks, tasking and dissemination processes, and so on. Because this construct will probably take years to develop, we cannot afford to wait for a crisis to occur.

Education and Training

Often an afterthought, education and training are paramount to success. Too frequently we have sent space operations personnel into combat with inadequate experience and training. It is vital to properly organize, train, and equip our space forces. Although the United States has made improvements to develop space professionals, we need specialists. During the last decade, space weapons officers have filled this role. Because the position is adapting to focus more on Air Force Space Command units and because of the limited number of positions, the Air Force needs to develop a track for personnel specializing in the integration and exploitation of space. Either the Army's FA-40 program or the Air Force Space Weapons Instructor Course can serve as models. Most nations have neither military space systems nor military space specialists, so they must develop personnel with space expertise and establish a career specialty.

Because coalition space teams require trained personnel, partner nations must establish training programs to develop specialists who can integrate space into ground, air, and sea operations.

Before developing a specialty, we must clearly understand the operational requirements for space capabilities. Army Field Manual 3-14, *Space Support to Army Operations*, May 2005, clearly defines the roles and tasks of an Army SST and a space operations officer.[37] We have high expectations for deployed space personnel, who must know all of the national space systems, capabilities, limitations, and supporting organizations; understand the CJTF's mission, priorities, and operations; and then figure out how to integrate them into the planning process. They must coordinate with a multitude of intelligence and space organizations, monitor the status of space systems for changes, determine possible effects on the theater, and track vulnerabilities and threats. Theater space officers may also perform other classified duties. In a coalition environment, they will carry out these duties for other nations' space assets and processes. After training and developing senior captains and majors to best support our theater commanders, the Air Force must groom these officers for more advanced positions. Therefore, to meet the above requirements, we should organize a small cadre of US joint and allied space planners and liaison officers.

Several existing training programs can begin to address these needs. As one would suspect, the United States offers the majority of space training. However, Canada, the United Kingdom, France, and NATO also have space courses. Selecting the best aspects of each of them should enable us to develop the requisite courses. Because joint and allied commanders and operational planners need a basic awareness of space capabilities and limitations, staff colleges and other advanced schools should include space familiarization in their curricula. Similarly, senior political and military leaders would benefit from an executive space course that covers strategic space issues, just as commanders and staffs would profit from a course on military applications of space. NATO members should have access to such courses at a reasonable cost. Furthermore, at the more advanced level, the NATO school in Germany offers the only operational planning course for space, which attempts to teach staff officers and operational planners with little or no space background how to integrate space into the operational planning process in just five days—simply not enough time. Indeed, the basic and advanced training that students need could take months. Without proper education and training, we will continue to provide only adequate rather than optimal support to our theater commanders.

Equipment and Planning Tools

We can't send our space warriors into the fight without tools. For situational awareness, teams must have an integrated space picture—including US, coalition, adversary, and commercial space assets—similar to the information about our land, sea, and air forces. We must monitor and display system and network status and assess effects on the theater. Teams must have planning and coordination tools so they can share information at a common classification level in a coalition environment. Chat programs, e-mail, and phone networks must be interoperable and allow sharing amongst coalition nations. Computer systems should be capable of handling information up to at least a Secret classification. (The removal of sources, means, and methods permits the release of most intelligence information and products.) In order to move forward, we must produce fused intelligence products, and many nations must contribute to that process. Most importantly, because all coalition forces must be aware of available capabilities and products, the United States should no longer confine itself to national systems but begin operating on coalition network systems.

Space personnel also need certain types of equipment. Army SSTs, for example, have their own deployable SATCOM terminals and computers with which they can obtain or produce space products such as three-dimensional visualizations, satellite-overflight reports, communication-interference reports, and imagery maps. Using satellite connectivity, they can monitor the space environment, operational status of space vehicles, effects of solar weather, and other space events. They also can serve as a primary missile-warning node. However, these US teams are not ideally enabled for coalition operations because they cannot release many of their products to partner nations. In addition to having an integrated space picture, a coalition SST must be able to produce satellite-overflight predictions, analyze communications links, analyze and manage ISR resources, assess threats, and conduct electronic warfare/countercommunications planning, as well as perform many other tasks. Hence, they need deployable SATCOM capability, not to mention information systems and software to support operations, the latter including such products as the widely used Satellite Toolkit from Analytical Graphics, which can help coalition SSTs do their jobs.[38] Commanders cannot fight without knowing the location and status of their aircraft, ships, and land forces at any given time; consequently, coalition nations must contribute orbital information, aircraft information, and data to create an integrated picture. Sadly, the current state of a coalition's space situational awareness is minimal at best.

Conclusions

During the past 15 years, the United States has experimented with, developed, and fielded space forces to support theater commanders. Capabilities and personnel have matured and have more jointness than before, but today's coalition operations demand that we better integrate space capabilities into the fight. Recently, some allied nations have developed their own space capability. It is now time for the next step: coalition space operations. Thus, we must address doctrine, organization, command and control, education and training, equipment and tools, as well as our bilateral agreements for space cooperation, which do not suffice for coalition space operations.

Ongoing coalition operations in Kosovo, Iraq, Afghanistan, and elsewhere motivate us to better integrate and use all available space capabilities. Improving the way we organize, train, and equip our forces will enhance the space effects available to joint and coalition war fighters. Space is for everyone, including our adversaries, so we mustn't delay. ✪

Notes

1. The Joint Air Power Competence Centre was established in 2005 as a Centre of Excellence to enable NATO's effective and efficient use of joint air and space power. A think tank, the center offers independent thought, analysis, and solutions at the strategic and operational levels. Maj Thomas Single, *NATO Space Operations Assessment*, rev. ed. (Kalkar, Germany: Joint Air Power Competence Centre, January 2009), I–II.

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11. "Sicral," *Deagel.com*, http://www.deagel.com/C3ISTAR-Satellites/Sicral_a000214001.aspx (accessed 18 February 2010); and "COSMO-SkyMed," Telespazio, http://www.telespazio.it/cosmo.html (accessed 18 February 2010).

12. Germany launched five "SAR-Lupe" satellites from 2006 to 2008. See "SAR-Lupe," OHB System, http://www.ohb-system.de/sar-lupe-english.html (accessed 17 February 2010). Germany also launched the TerraSAR-X satellite in 2007. The TanDEM-X SAR satellite is scheduled for launch in 2010. See "TanDEM-X: A New High Resolution Interferometric SAR Mission," DLR, http://www.dlr.de/hr/desktopdefault.aspx/tabid-2317/3669_read-5488/ (accessed 18 February 2010); and "Launch 2008," RapidEye, http://www.rapideye.de/home/system/launch-2008/index.html (accessed 18 February 2010).

13. "SatComBw/ComSatBw-2," EADS Astrium, http://www.astrium.eads.net/en/prog/satcombw-comsatbw2.html (accessed 16 April 2010).

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34. FM 3-14.10, *Space Brigade Operations*, October 2007, chap. 2.

35. AFDD 2-2, *Space Operations*, describes the position of director of space forces; JP 3-14, *Space Operations*, addresses space coordination authority; and JP 0-2, *Unified Action Armed Forces*, 10 July 2001, examines coordination authority. All three documents suggest that the director and space coordination authority are more appropriate for planning than for combat operations.

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38. The author neither represents nor endorses this company. For information about products from Analytical Graphics, see http://www.agi.com.

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