

Bridging the Gap

European C4ISR Capabilities and Transatlantic Interoperability

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Executive Summary

This study is the result of a two-year examination of the presumed defense technology gap between the United States and Europe that focused on information and communications technologies and their integration into military systems, which allow military forces to be networked from sensor to shooter and back in what has come to be called network centric warfare.

These command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) technologies are at the heart of modern warfighting. They act not only as force multipliers for the military platforms into which they are integrated, but also as the means to better link different types of forces (air, sea, land). Moreover, they can connect forces of different nationalities, enabling interoperability and the efficient use of military resources.

The study analyzes the deployed and planned C4ISR capabilities of seven European countries: France, the United Kingdom, Germany, Italy, the Netherlands, Spain, and Sweden. Capabilities discussions are divided into command and control (C2), communications and computers, and intelligence, surveillance, and reconnaissance (ISR). We examine the extent to which advanced C4ISR and network doctrines figure in the defense planning of these nations and explore the extent of interoperability within and between these national forces and between these forces and those of the United States.

The study also examines the C4ISR doctrines and capabilities of the NATO alliance and C4ISR-related work being done under the aegis of the European Union (EU).

European security space capabilities are discussed both within country chapters and in a separate chapter, because an increasing number of space programs is being undertaken at the multinational level. Furthermore, European space capabilities are significantly dual-

use in nature, being developed and sponsored, in most cases, by non-defense ministries and multilateral institutions, but with important emerging defense applications.

Findings

This detailed examination of the capabilities of seven countries leads to a number of conclusions about European C4ISR capabilities:

While none of the European allies studied is likely to field a fully networked military in the foreseeable future, all have a greater commitment to the deployment of C2 and communications capabilities that link their national forces closer together and provide greater interoperability within the NATO alliance than is sometimes thought. All are planning or deploying digital communications, cross-service C2, and several types of ISR platforms (manned, unmanned and/or space-based). Planned and actual deployments are broader and further advanced in some countries—notably France and the United Kingdom—while they lag in others.

The biggest constraint on European C4ISR investment is overall limitations on defense budgets, not the absence of adequate technology. Nevertheless, all countries are putting some priority on investments in C4ISR systems and the requirements of network centric operations.

Europeans agree that interoperable C4ISR is essential to transatlantic coalition operations. They recognize that achieving such interoperability will depend on their investing in modern C4ISR capabilities, including in the framework of the EU and NATO. They also express a strong desire for U.S. cooperation on C4ISR, both in terms of technology transfer and in designing U.S. military systems to be interoperable with the European ones.

NATO provides the most up-to-date and complete framework for addressing transatlantic C4ISR technology and interoperability issues. However, NATO is an uncertain context for future planning, given the commitment of the Europeans to strengthening capabilities in the EU setting, and given U.S. ambiguity about its commitment to coalition operations in general and to planning and executing those operations in the NATO context in particular.

C4ISR interoperability among the Europeans is most advanced in the area of space. European governments support a common European space policy, and a growing number of multilateral European space initiatives are underway, as are programs to link existing national capabilities. In addition, European policymakers recognize the security implications of their civilian space programs, such as Galileo, and are shifting resources toward the security aspects of these programs.

While the EU is slowly becoming an important context for coordinating European policy, requirements, and acquisitions in the C4ISR arena, its military planning is still too preliminary to provide a setting for resolving interoperability problems. The trend toward a more common defense capability in Europe, somewhat autonomous from the NATO alliance, is likely to have major implications downstream for coalition military operations.

Recommendations

The technological, economic, and military benefits that intra-European and transatlantic collaboration on C4ISR could bring are not being adequately realized. The findings of this study suggest a number of policy actions, in Europe, in the United States, and particularly in NATO, which could significantly improve European C4ISR capabilities and their interoperability with each other and with the U.S. military:

The European allies need to make a clear commitment to the goals of intra-European and transatlantic interoperability in C4ISR within NATO and EU defense planning contexts. Our study suggests that this commitment is not strong at the trans-European level and is uneven at the transatlantic level.

The NATO context is the most promising place to address the transatlantic interoperability issue systematically. European governments need to move more quickly in the NATO Standardization Agreement (STANAG) framework and need to urge that coverage be broadened to include standards for surveillance and reconnaissance systems. The governments should engage as fully as possible in the work of Allied Command Transformation (ACT), which has the potential to be a critical context for the transatlantic dialogue on C4ISR and networked operations.

A similar commitment needs to be made at the EU level, in the framework of the Headline Goal and European Capabilities Action Plan (ECAP) processes. While C4ISR interoperability issues are on the table in the EU policy process, they do not appear to have received priority attention.

A plug-and-play strategy makes sense for Europe. The model is for the United States or NATO, or both, to provide the backbone for a network and for the Europeans to select the points in the grid that are critical to ensure interoperability. Interoperability will be central with respect to the transmission,

in a timely way, of voice, data and images—the information that enables networked operations. The plug-and-play strategy would rely on common standards and capabilities and on ensuring that these are shared, commonly deployed, and secure.

U.S. policy needs to focus on four dimensions of the transatlantic defense trade problem: an understanding of European strategic perspectives; taking European C4ISR technology and interoperability capabilities and intentions seriously; working through NATO to enhance the opportunities for greater connectivity; and transforming the U.S. regime for transatlantic defense trade to incentivize interoperability decisions, transatlantic technology collaboration, and industry efficiency.

The NATO Response Force (NRF) should be a test bed for addressing the transatlantic C4ISR interoperability gap. The United States will provide initial logistical and C4 support to the force; Europeans are expected to provide these capabilities on their own eventually. The United States sees the NRF as a litmus test for European willingness to develop integral C4ISR that can interoperate with U.S. forces. Given the need to stand up the NRF by 2006, the European allies should focus on meeting NRF C4ISR requirements as a near-term demonstrator for C4ISR capabilities that will have applications to European capabilities down the road. The United States should do everything in its power to assist this effort.

Introduction

In the history of the Atlantic Alliance, there has never been a time when American policymakers have felt that the European allies produced an adequate capability to meet the requirements of Alliance war plans. In early years, there was little concern about this dissatisfaction, as supporting European recovery from the ravages of WWII had a higher priority. In the past decade, however, as NATO forces have been more actively used in combat and post-combat situations, the adequacy of the European military capability has been more actively debated. U.S. defense planners have regularly expressed concern about the ability of European military forces to operate together with those of the United States, the so-called interoperability problem. The European allies, albeit sometimes praised for their military contributions to the Alliance, were seen at various times (alternately) as producing forces with inadequate training, support, equipment, or technology, or not designed to connect to U.S. forces.

In the 1990s, the disparity between the military capabilities of the United States and of European members of NATO came to be called a gap.¹ Starting with the U.S. buildup of the 1980s, through the deployment and warfare of the first Gulf War, the Bosnian conflict, and the Kosovo air war, it seemed clear that several changes had taken place in U.S. military capabilities. Those changes opened up great distance between the military capabilities on the two sides and began to pose a threat to the very ability of the alliance to function as a military partnership.

The gap stemmed from several concurrent developments in U.S. military planning, force development, and technology. At the level of strategy, the security concerns of the United States focused increasingly on security issues in regions at the periphery of or completely outside the European theater—particularly the Middle East

¹ See David C. Gompert, Richard L. Kugler, and Martin C. Libicki, *Mind the Gap: Promoting a Transatlantic Revolution in Military Affairs* (Washington, DC: National Defense University Press, 1999).

and Persian Gulf, North Asia, and the Pacific—and on more global security problems such as failed states, terrorism, ethnic and religious conflict, and the proliferation of weapons of mass destruction. Not only did NATO Europe become a secondary strategic concern; the global focus of the American military meant that the United States, and only the United States, maintained a capability to operate globally through near-continuous presence or expeditionary operations. In addition, the strategic focus of U.S. defense planning migrated almost completely away from a concern with war in particular theaters, to a focus on developing military capabilities that could reassure all friends and allies, dissuade potential military competitors anywhere on the globe, deter adversaries, and defeat any of them decisively.²

Second, U.S. military doctrine began to focus away from concepts of major land battle of massed armies, and sharply toward a doctrine that would ensure U.S. ability to be “dominant across the full spectrum of military operations,” through a combination of “dominant maneuver, precision engagement, focused logistics, and full dimensional protection.”³ This change in doctrine required, in turn, a transformed military: different operational concepts, different training, and different technology.⁴ U.S. forces needed to be global, capable of rapid movement to far-flung locations, and knit together by global communications, C2, and sensors.

Putting such forces in place meant, for the United States, relying on a technological revolution that had been taking place for twenty-five years. Rapid change in information and communications technologies during this period made it possible to imagine, develop, and deploy revolutionary changes in military doctrine, operations, and capabilities. Despite shrinking defense budgets in the 1990s, the U.S. military began to

² See Department of Defense, Office of Defense Transformation, *Military Transformation: A Strategic Report* (Washington, DC: Department of Defense, Fall 2003), 4-5.

³ Joint Chiefs of Staff, *Joint Vision 2020* (Washington, DC: Department of Defense/Joint Chiefs of Staff, June 2000), 2-3.

⁴ Department of Defense, Office of Defense Transformation, *Military Transformation: A Strategic Report*, (Washington, DC: Department of Defense, Office of Defense Transformation, 2003), 8. This document defines transformation as: “A process that shapes the changing nature of military competition and cooperation through new combinations of concepts, capabilities, people and organizations that exploit our nation’s advantages and protect against our asymmetric vulnerabilities to sustain our strategic position, which helps underpin peace and stability in the world.”

undergo this technological transformation, pushing increasingly in the direction of what has come to be known as network centric warfare (NCW). As defined by DOD, NCW “refers to the combination of emerging tactics, techniques, and technologies that a networked force employs to create a decisive warfighting advantage.” NCW “accelerates our ability to know, decide, and act, linking sensors, communications systems, and weapons systems in an interconnected grid.”⁵

U.S. forces have demonstrated this increasingly networked, global, and dominant capability starting with the first Gulf War, as well as in the Balkans and, most recently, in combat operations in Afghanistan and Iraq. At the same time, it has been argued, European allies have failed to invest in building such a capability and have been inattentive to the need to connect to American forces. Europeans, in this view, are no longer threatened by a major military adversary, and have allowed their defense capabilities to decline. European defense budgets shrank through the 1990s, and the allies made relatively small investments in the technologies that contribute to a networked capability. As a result, it became increasingly difficult for U.S. and European forces to operate in tandem, as the first Gulf War and, especially, combat operations in the Kosovo/Serbia air war demonstrated.⁶

American defense planners became increasingly critical of European defense efforts as this gap became more evident. Aside from the obvious differences in strategic outlook and expeditionary doctrine, the American critique focused on the lag in defense investment overall, and especially the lag in European attention to the technologies that

⁵ Ibid., 13. Gompert, Kugler, and Libicki describe the U.S. capabilities in the following way: “The United States...is poised to harness key information technologies—microelectronics, data networking, and software programming—to create a networked force, using weapons capable of pinpoint accuracy, launched from platforms beyond range of enemy weapons, utilizing the integrated data from all-seeing sensors, managed by intelligent command nodes. By distributing its forces, while still being able to concentrate fires, the U.S. military is improving its mobility, speed, potency, and invulnerability to enemy attack.” *Mind the Gap*, 8.

⁶ Gordon Adams, “Strength in Numbers: The European Allies and American Defense Planning,” in *Holding the Line: U.S. Defense Alternatives for the Early 21st Century*, ed. Cindy Williams (Cambridge, MA: MIT Press, 2001).

make NCW possible.⁷ European defense technologies, in this widely-held U.S. view, have fallen significantly behind in terms of their application to the conduct of modern, high intensity military operations.

The gap seems most obvious in the area of information and communications technologies, which are grouped together under the heading of C4ISR. The United States can gather and fuse data from a wide variety of sensors and integrate them into military operations in ways Europeans cannot. Europeans lack the C4ISR capabilities that link target intelligence to shooters in a secure, real-time manner. What is more, those technologies the Europeans do possess cannot connect smoothly to U.S. technologies, making coalition operations difficult or even dangerous. Going even further, some U.S. critics suggest that European information technologies lag behind the United States, making their application to defense needs and interoperability even more problematic to achieve.⁸

The gaps exposed by the Gulf War and the Balkans operations struck home to the European allies and stimulated a stronger commitment to developing European military capabilities within the NATO and EU contexts. In NATO, the European allies signed up to the Defense Capabilities Initiatives (DCI) in Washington in 1999 and the Prague Capabilities Commitments (PCC) in 2002. The also Europeans made a separate commitment, through the 1999 Headline Goal, to develop a common military capability for specified operations in the framework of the EU.

American defense planners have remained skeptical of European accomplishments in defense, particularly with respect to the European ability to conduct network centric operations using advanced C4ISR. The Headline Goal force is criticized as incapable of conducting 21st century combat missions and not interoperable with U.S.

⁷ Gompert, Kugler, and Libicki capture the essence of this critique: “The use of transformation technology is far more extensive in U.S. forces than in European forces. The quality of U.S. precision-guided munitions (PGMs) and C4ISR (command, control, communications, computers, intelligence, surveillance, and reconnaissance) has improved greatly since the Gulf War, whereas European forces still remain incapable even of the type operations that U.S. force conducted in 1991.” *Mind the Gap*, 4.

⁸ *Mind the Gap*, 74-77. See also John Deutch, Arnold Kanter, and Brent Scowcroft, “Saving NATO’s Foundation,” *Foreign Affairs* 78, no.6 (November/December 1999): 54-67.

forces. The European decisions to acquire new equipment, such as the A400M transport and Galileo satellites, are viewed in the United States as redundant and wasteful. In this common view, EU military goals will not be met, and will result in an inadequate force for modern warfare. The Headline Goal force will continue to rely on the United States (via NATO) for lift, logistics, and communications, and will continue to pose communications and information distribution problems.

This study was undertaken to examine, and to some degree question, the basic assumptions underlying this skeptical point of view. It focuses on the technologies at the heart of network centric capability: information and communications technologies that have been integrated into military systems, allowing national and coalition forces to be networked from sensor to shooter and back, or C4ISR technologies. The study takes a closer look at the claim that European forces have fallen hopelessly behind those of the United States and cannot close the gap.

The study tries to get behind the rhetoric of the gap to examine this claim. It does so, in part, because European defense ministries, planners, and industries have contended to us that the C4ISR gap is not as large as it appears. While European defense budgets, and especially European investment in military research and development (R&D), have declined significantly, the European defense industry has consolidated in a major way. The resulting firms, including BAE Systems, European Aeronautic Defence and Space Company (EADS), and Thales, among others, possess significant technological capabilities that are competitive, the Europeans argue, with U.S. technologies. Moreover, Europeans argue, in technology sectors that supply the most revolutionary capabilities—information, sensing, guidance, and communications, for example—Europe is completely competitive with the United States, and both draw on a truly global marketplace for many of these technologies.⁹

⁹ The International Institute for Strategic Studies has argued, in fact, that there is a considerable transatlantic technology market for component and supplier technologies, with the flow approximately equal in value in each direction. IISS, *The Military Balance, 1998-99* (London: International Institute for Strategic Studies, 1998) 273.

In this study, we have systematically examined the C4ISR capabilities of seven European countries, six of them NATO allies—France, the United Kingdom, Germany, Italy, Spain and the Netherlands—and one non-NATO country, Sweden. These countries were chosen as the NATO allies with the largest defense investment, the most modern forces, and, in varying degrees, the strongest commitment to deploying advanced C4ISR and achieving interoperability with the United States. In the Swedish case, a clear commitment to network centric capabilities and to greater interoperability suggested the need for focused examination, even though Sweden is not a NATO member.

In exploring the capabilities of each of these countries through research and interviews, we endeavored to understand the extent to which advanced C4ISR and network doctrine figured in European defense planning overall. We then looked at deployed C4ISR capabilities and current research and technology (R&T)¹⁰ programs on such technologies, both for the extent to which they used advanced capabilities and the degree of interoperability built into the systems. We somewhat arbitrarily divided the examination into discussions of C2, communications and computers, and ISR. From the perspective of network centric operations, of course, these elements of C4ISR are and must be integrated. With respect to interoperability, to the extent possible, we examined three aspects: the degree to which European national military forces are interoperable across services, across Europe and within NATO, and with the United States.

To anticipate a conclusion, we found a higher European commitment to deployed and planned advanced C4ISR capabilities than is often assumed. While no European ally is committed to a fully networked force, all have a commitment to the deployment of C2 and communications capabilities that link their national forces more closely and provide greater interoperability within the NATO alliance. All are planning or deploying digital communications, cross-service C2, and manned, unmanned, or space-based ISR platforms. European deployments and plans are broader and further advanced in some countries—notably France and the United Kingdom—while they lag in others. Although

¹⁰ We use R&T in this case to focus on technology research investments, as opposed to investments that focus on the development end of military platform acquisition.

defense budgets are limited, all countries are pointing at least some of their investment in the right direction.

Going beyond the national level, we thought it important to examine C4ISR issues and interoperability in the context of the NATO alliance. NATO is the one multilateral setting in Europe in which C4ISR issues are formally addressed and joint programs most fully developed. Institutional attention to these issues is far more advanced in NATO than, to date, in the EU. Moreover, recent initiatives in the NATO context—the PCC, the NRF, and the ACT—all give specific, high-priority attention to developing interoperable, network centric capabilities. NATO, in our view, is probably the most important context for focusing on what needs to be done to close the gap with respect to C4ISR.

The study also closely examined defense planning taking place in the framework of the EU. Although C4ISR is not yet a central focus of that planning, it is our view that the common defense effort in the EU is serious and long-term. It also is commonly and incorrectly ignored by U.S. defense planners. The trend toward a more common defense capability in Europe, somewhat autonomous from the NATO alliance, could have major implications downstream for joint military operations. Moreover, to the extent Europe develops an autonomous capability, it will require dedicated C4ISR assets, a reality of which European defense planners are fully aware.

European defense-related space capabilities received a chapter of their own. Space systems are important to C2, communications, and ISR. The section on national C4ISR capabilities describes the space systems currently deployed or under development in the seven countries that were studied. A separate discussion, however, is necessary to provide a broader European perspective. There are two reasons for this. First, European space capabilities are developed and sponsored, in most cases, by non-defense ministries and multilateral institutions, but with important emerging defense applications. Second, in some ways, multilateral interoperability at the European level is most advanced in the arena of space, making it an important case to highlight.

The study concludes with recommendations. There clearly are capabilities gaps and interoperability problems across the Atlantic, though they are neither as extreme nor as powerful a barrier to transatlantic interoperability as is sometimes claimed. The capabilities gap is, to some degree, a misperception. Only the United States has set for itself the twin goals of global operations and a fully network centric military force to conduct those operations. European agendas are more modest with respect to geographic reach and the creation of a fully networked force.

This does not mean, however, that American and European military forces cannot be productively connected. There appear to be clear ways to link them together for effective operations and a number of programs are under way to do so. There are also important gaps in connectivity that need to be addressed. There is a good deal of work to be done, both by Europe and by the United States, to close those gaps that exist and to take fullest advantage of current programs. Our conclusion lays out an agenda both the United States and its allies need to address so that a working order can be established with respect to transatlantic C4ISR.

European C4ISR Capabilities

This chapter describes in detail the C4ISR capabilities of seven European countries: France, the United Kingdom, Germany, Italy, the Netherlands, Spain, and Sweden. These countries invest in much of the European C4ISR capability in terms of deployed forces, planned acquisitions, R&T programs and network centric doctrine. Not surprisingly, they are also the countries with the highest defense budgets in Europe (with the exception of the Netherlands). Finally, these seven countries are among the most likely partners of the United States in future coalition operations, whether individually or as members of multinational organizations, such as NATO and the EU.

Initially, this section will review some of the overall trends in C4ISR-related acquisition and R&T programs of all these countries, pulling together trends that have been observed in several—if not all—of them. The chapter then reviews C4ISR developments in each country, with a brief overview of major national capabilities and strategies, followed by an examination of C4ISR capabilities broken down into C2, communications (including computers), and ISR. Each country discussion describes both deployed and planned systems with particular attention to interoperability issues. Where the country has deployed a C4ISR system in support of coalition operations, the discussion reviews the success—or lack thereof—in achieving interoperability with other systems fielded at the same time.

The first two country discussions—France and the United Kingdom—include a detailed description of national doctrines and strategies related to transformation and network centric operations. While each has its own reasons for doing so, both France and the United Kingdom are currently the European leaders in integrating advanced C4ISR technologies into their military forces.

Overview

In all of the Western European countries examined in this study, several general processes are under way to upgrade national, and in some cases multinational, C4ISR capabilities. No country has fully embraced the concept of network centric operations to the extent the American military has. None are seeking to create a full, single infrastructure fusing all existing and future assets. Most have opted, at least, for some integration and upgrading of existing capabilities toward greater networking. Major procurement programs focus particular attention on cross-service C2 systems, digital communications, and ISR platforms (tactical, operational, and strategic). In all of these countries, rapid advances in commercial communication and information technology have created a wealth of products applicable to military C4ISR at a relatively low unit cost. As a result, for many of these countries, expensive weapons platforms can be improved through C4ISR-related upgrades, thereby increasing capability at an affordable cost.

Connecting existing C2 systems across services within the militaries of many European countries is already under way. Several countries are creating a new, cross-service C2 infrastructure, including the United Kingdom Joint Command System (JCS), France (SICA), and Italy (CATRIN). Interoperability among these C2 systems is significantly less advanced, especially for ground forces. The French army, for example, has three command levels, while most other European armies—including the United Kingdom, Germany and Italy—have two, which makes the creation of a common C2 architecture a challenge.

All of the countries reviewed believe that a common digital communications backbone for their services is crucial. Several countries field tactical systems based on asynchronous transfer mode (ATM) switches; many others have integrated digital switches capable of interfacing with high-speed data networks and complying with European and NATO standards. Many of them are at advanced stages in upgrading their communications infrastructure, whether through terrestrial networks, satellite systems, or a combination of both, including the British Bowman and Skynet programs, the German

AUTOKO-90 and BIGSTAF programs, and the French SOCRATE, RITA-2000, and Syracuse programs. Sweden, the Netherlands, and Italy are also making significant progress in the military communications field.

For communications in general, the civilian industry is the main driver of innovation and, therefore, the main standard setter. It is not surprising that while different companies are working on communications programs for Europe's militaries, the systems being put in place share attributes: they are digital, increasingly based on the Internet Protocol (IP), capable of handling voice as well as data, and use ATM switching equipment and widespread transmission technologies (satellite, radio, and fiber optics).

In addition to space-based military communications, many European countries are turning to space for future surveillance and reconnaissance capabilities. While military communications satellites (COMSAT) usually are built and operated by individual countries, earth observation programs have become increasingly multinational. Furthermore, intra-European agreements are being put in place to link national space assets. In the not-so-distant future, data collected by satellites owned by different countries will be disseminated between partners through sharing agreements, and COMSATs will carry military transmissions from countries leasing bandwidth. A growing number of countries are acquiring the capability to link their headquarters with their expeditionary forces using broadband mobile communications. The French ARISTOTE, the German KINTOP, the British Cormorant, and the Swedish KV90 are examples of such systems already in place.

Finally, the Europeans are making increased use of unmanned platforms, especially aerial ones, for tactical and, in some cases, operational and strategic ISR needs. While all of the countries reviewed possess or have upgraded manned platforms for ISR missions, particularly aerial reconnaissance, these are nearing the end of their service lives. All the militaries discussed have begun to experiment with unmanned aerial vehicles (UAV) (many of them developed by their indigenous industry), and most have used them in military operations. They are viewed as affordable, versatile, and

dependable options for future surveillance and reconnaissance missions. Several countries, notably the United Kingdom, France, and Germany, are looking to UAVs for other operational needs, including signals intelligence (SIGINT), electronic warfare, airborne ground surveillance, and strike missions. However, unlike communications and C2, different ISR standards are set by each country, making interoperability even more difficult.

Table 1. Main European national C4ISR strategies and capabilities

	Strategy	C2	Communications	ISR
France	<ul style="list-style-type: none"> ▪ Across-the-board investments in C4ISR ▪ Expeditionary forces 	<ul style="list-style-type: none"> ▪ SICA 	<ul style="list-style-type: none"> ▪ SOCRATE ▪ Syracuse ▪ AF and navy possess Link-11/16 	<ul style="list-style-type: none"> ▪ UAVs (incl. MALE & HALE) ▪ Helios 1 (Helios 2 underway) ▪ Limited AGS (4 Horizon helos) ▪ AWACS (4) ▪ SAIM (data management, interoperable with JSTARS, Horizon systems)
United Kingdom	<ul style="list-style-type: none"> ▪ Network enabled capabilities (NEC) ▪ Defense Information Infrastructure (DII): integration of all C4 systems ▪ Expeditionary forces 	<ul style="list-style-type: none"> ▪ JCS 	<ul style="list-style-type: none"> ▪ Bowman ▪ Skynet ▪ RAF and RN equipped with U.S. comms. (Link-11/16, JTRS) 	<ul style="list-style-type: none"> ▪ Phoenix TUAV; ▪ Watchkeeper underway ▪ AGS coming soon (ASTOR) ▪ AWACS (7) with JTIDS ▪ Nimrods (18) ▪ GRIFFIN info-sharing WAN
Germany	<ul style="list-style-type: none"> ▪ Modernization of forces ▪ Expeditionary forces 	<ul style="list-style-type: none"> ▪ Pilot Project 9.4.4 (not anytime soon) 	<ul style="list-style-type: none"> ▪ Autoko-90 ▪ SATCOM-BW ▪ AF: MIDS ▪ Navy: Link-11 and MIDS 	<ul style="list-style-type: none"> ▪ UAVs (TUAVs, MALE, HALE) ▪ SAR-Lupe ▪ AGS proposed via HALE (Euro Hawk) ▪ GAST: common system for ISR data
Italy	<ul style="list-style-type: none"> ▪ Selective acquisition of C4ISR assets (UAVs, space) 	<ul style="list-style-type: none"> ▪ CATRIN 	<ul style="list-style-type: none"> ▪ SICRAL 	<ul style="list-style-type: none"> ▪ Limited AGS (4 CRESO helos) ▪ UAVs (incl. Predator) ▪ COSMO-Skymed
Netherlands	<ul style="list-style-type: none"> ▪ Specialization (UAVs, comms.) 	<ul style="list-style-type: none"> ▪ No cross-service C2 system 	<ul style="list-style-type: none"> ▪ TITAAN (tactical IP network) ▪ Limited MILSATCOM 	<ul style="list-style-type: none"> ▪ UAVs (TUAVs, MALE codevelopment with FR)
Spain	<ul style="list-style-type: none"> ▪ Modest investment 	<ul style="list-style-type: none"> ▪ No cross-service C2 system 	<ul style="list-style-type: none"> ▪ Hispasat 	<ul style="list-style-type: none"> ▪ Limited ISR capabilities
Sweden	<ul style="list-style-type: none"> ▪ Network-Based Defense ▪ Expeditionary forces 	<ul style="list-style-type: none"> ▪ ROLF 2010 (national C2 system integration concept) 	<ul style="list-style-type: none"> ▪ HF-2000 	<ul style="list-style-type: none"> ▪ Limited AGS (6 ARGUS aircraft) ▪ Beginning to look at UAVs

France

France invests in almost all areas of defense technology relevant to C4ISR. For decades, France has pursued an overall defense doctrine and procurement strategy that would provide independent and autonomous military capabilities. As a result, France is the only country other than the U.S. investing across the board in defense technologies. France prefers to remain as flexible as possible, through the deployment of a varied arsenal and the avoidance of military specialization. Even within the framework of French policies toward the emerging EU defense capability, French policy tends to emphasize the importance of viewing those capabilities as potentially autonomous of the NATO alliance (see below).

The broad French investment in C4ISR capabilities is not, therefore, a direct result of a comprehensive network centric doctrine, which is not yet in place. Within the French Joint Staff, only a handful of officers currently work on network centric operations. However, between 1991 and 1993, several new organizational frameworks were created to review and modernize French doctrine and strategy in this direction. The single joint Directorate of Military Intelligence (*Direction du Renseignement Militaire*, or DRM) replaced a variety of existing services and reports to the chief of the defense staff. A joint planning staff, the *Etat-Major Interarmées* (EMIA), was created to plan operations in and out of Europe, and the *Centre Opérationnel Interarmées* (COIA) became the joint operations center. France also put in place a joint theatre C2 structure (*Poste de Commandement Interarmée de Théâtre*, or PCIAT)¹¹ and the space bureau in the French Joint Chiefs of Staff was folded into the Command, Control, Communications, and Intelligence (C3I) staff. The initial purpose of these organizational changes was to facilitate force projection and of expeditionary warfare operations. However, these new organizational structures could provide a setting for a military doctrine increasingly focused on transformation and coordination across services,

Because force projection, expeditionary forces, and out-of-theater operations require, among other things, advanced C2 systems, communications networks, and real-time intelligence, the C4ISR systems that provide this are playing an increasingly important role in French military

¹¹ James P. Thomas, *The Military Challenges of Transatlantic Coalitions*, Adelphi Paper 333 (London: IISS, May 2000), 20.

plans. Recently, the French defense procurement agency (*Délégation Générale pour l'Armement*, or DGA) set up a task force of eight systems architects (*architects des systemes de force*) in charge of future issues for defense R&D and procurement and their cross-service applications. These issues include nuclear weapons and C4ISR systems. The task force meets regularly with representatives of the French defense industry to coordinate government requirements with private-sector projects and planning.¹²

More changes in organizational structure are expected to begin in 2004. The DGA will be restructured to include expanded and improved in-house technical capabilities for research, technology, and testing to spend its budget more efficiently. The French Joint Chiefs of Staff and the Office of the Secretary-General of the Defense Ministry will assume responsibility for monitoring the development and demonstration of defense programs, a responsibility currently held by the DGA. These changes are seen as a way to bring industry closer to its client, the French military.¹³

The importance of C4ISR for current and future French military capabilities is reflected in the 2003-2008 defense budget plan. C2 systems, space technologies, and interoperability enablers have received priority for R&D investment. During the first two years (2003-2004), DGA planners are focusing on space-based SIGINT assets, a space-based early warning system demonstrator, integrated C2 systems for the army and navy, and advanced navigation technologies. For 2005-2006, the priorities are UAVs and the interlinking of European space assets.¹⁴ For all C4ISR requirements, DGA's Directorate of Prospective Systems (*Direction de Systemes Prospectives*, or DSP) will decide on the best and most affordable solution, without prejudice toward any specific technology.

The DGA also is working on two plans to assess the future needs of the French armed forces. The first is a technological capabilities plan of systems, including C4ISR systems, to be acquired by the year 2015. The second is the Prospective Plan for 30 Years (*Plan Prospectif à*

¹² Thales has created the Thales Think Tank (T3) to act as permanent liaison with this DGA task force.

¹³ Tran, Pierre. "Eyes on Smart Procurement: French to Restructure Industry, Defense Ministry". *Defense News*, 19 January 2004.

¹⁴ DGA. *Les Démonstrateurs Aéronautiques et Spatiaux*. DGA Dossier, June 2003.

Trente Ans, or PP30), which looks specifically at longer-term needs, mainly in the fields of telecommunications, intelligence, networking, C2, sensors, and UAV technologies. These plans will be updated annually to guide R&T investments and procurement plans.

The DGA also is well aware that the procurement of existing land, sea, air, and nuclear platforms could put this transformation plan at risk. PP30, for example, includes a section on cooperation with European and U.S. allies and the need for interoperability with non-French systems.

More broadly, recognizing the costs of an autonomous French defense strategy, France has also begun a substantial move toward defense cooperation within the EU and NATO contexts. France is seeking to create a military force of 20,000 to 30,000 troops that will be fully interoperable with allied forces. This force will be the subject of experimentation until 2006, initially at the brigade level. In the NATO context, France sees the ACT as an important development and a target for closer cooperation.

Transatlantically, the major French assets, notably the *Charles de Gaulle* aircraft carrier, have good tactical communications interoperability with the U.S. Navy, thanks to Link-16 technology.¹⁵ At the European level, French naval and air forces are fairly interoperable with most European forces, but French ground forces are not. The French Army still fields communications systems that are not interoperable with its allies.

As a European leader in space, France also seeks greater cooperation with the United States, especially for earth observation, communications, and navigation programs. France also views itself as a potential intermediary between the United States and the space-related activities of other European nations and organizations, including the European Space Agency (ESA) and the European Commission (EC).¹⁶

¹⁵ In Afghanistan, French E-2C aircraft from the *Charles de Gaulle* guided American fighters toward their targets when U.S. E-2C aircraft were overtaxed or unavailable.

¹⁶ Hura Myron. et. al., *Interoperability: A Continuous Challenge in Coalition Air Operations* (Washington, DC: RAND 2000), 64-65.

France is also committed to the NRF, despite seeing it as an American effort to duplicate the EU Rapid Reaction Force. Yet while it is looking to participate, it is also interested in maintaining flexibility in that commitment. It is unlikely that France will agree to periodically rotate the same forces through the NRF; it would be more interested in NRF experience for different kinds of troops drawn from various services. While the French understand that smaller countries will participate in the NRF in a specialized manner, they believe that many of the bigger countries will not accept this. Instead, most will opt for rotating different types of forces and maintaining autonomy in terms of NRF commitments.

France is also committed to the EU defense effort. The French strongly believe that there needs to be a European flag on European military capabilities. At this point, it is unclear to the French whether the EU plans to complement U.S. capabilities or prepare its forces for independent operations. This issue has major implications for interoperability requirements and capabilities. Currently, France is very supportive of the effort underway to create a European Defense Agency (EDA) with R&T and procurement responsibilities.

From the French point of view, the European investment in platforms stands in the way of greater interoperability between European C4ISR systems. European defense budgets include a major commitment to a platform strategy, which leaves little funding for C4ISR and interoperability.

In both deployed and planned systems, France possesses arguably the most advanced operational battlespace digitization program in Europe. While full interoperability between all services in the French armed forces has yet to be achieved, the major initial investments in cross-service systems have been made, and their deployment is well underway in all services. The major building blocks for this have been a cross-service C2 system, a digital communications infrastructure, and a network linking national HQs and expeditionary forces. France has also invested heavily in its ISR capabilities, and has not neglected any particular area. In fact, it is probably the only European country to have invested across the whole ISR board. Thus, it currently fields an arsenal that includes numerous types of UAVs as well as manned air- and ship-borne platforms, and space-based assets.

Command and Control

France has deployed C2 systems in all services. The army has the Force Command and Information System (*Système d'Information et de Commandement des Forces*, or SICF) for division-level C2 (including C2 for overseas task forces), the Regimental Information System (*Système d'Information Régimentaire*, or SIR) originally for regimental-level C2, but redirected to company level in 2001 (450 command post vehicles will have this system installed), and the Final Information System (*Système d'Information Terminal*, or SIT) for tactical-level C2. SICF and SIR are both compliant with NATO STANAGs. Other existing C2 systems are Martha for air defense, the air force's Aerial Operations Command and Control System (*Système de Commandement et de Contrôle des Opérations Aériennes*, or SCCOA), the artillery corps' Atlas, and the navy's Naval Tactical Information Exploitation System (*Système d'Exploitation Navale des Informations Tactiques*, or SENIT) installed on frigates and aircraft carriers. The interoperability of these systems among themselves and with allied systems is currently far from complete, although SCCOA is planned to be interoperable with the NATO Air Command and Control System (ACCS), and Atlas is currently interoperable with United States, United Kingdom, Italian and German surface-to-surface firing systems as well as with SIR).

The French navy has also deployed Cooperative Engagement Capability (CEC) systems on several vessels. Ships equipped with it can operate as a single, distributed anti-aircraft systems. This system is also deployed on ships of the United States and British Royal Navy, which enables interoperability in naval air defense between forces of these countries.

France is in the initial stages of deploying its next generation of C2 systems in the form of a strategic-level system called the Joint Information and Command System (*Système d'Information et de Commandement des Armées*, or SICA). Additionally, there are plans for the development of a next-generation C2 system for the navy (project SIC21) in 2004, and a heliborne C2 system for the air force's helicopters is being considered under project C2H.

Communications and Computers

The current communications infrastructure serving all of France's armed services is the Operational System of Joint Telecommunications Networks (*Système Opérationnel Constitué des Réseaux des Armées pour les Télécommunications*, or SOCRATE). Its 120 ATM switching sites around the country cover all military communications, including radio, fiber optic, and satellite communications, and connect the system to civilian and allied communications networks. Additionally, a more advanced tactical communications system for the French Army will enter into service around 2004-2005. It will be based on IP-networked PR4G (VHF tactical radios used in man-portable, vehicle-mounted, or aircraft-mounted configurations) and the Automatic Transmission Integrated Network (*Réseau Intégré de Transmissions Automatiques 2000*, or RITA 2000) switching platform, both supplied by Thales. The RITA 2000 project was initiated in 1993, and has since then progressively upgraded the French tactical communications infrastructure to facilitate interoperability with allied networks, expeditionary forces and increased bandwidth. Its link into the armed forces' C2 network is known as the Command Network Center (*Centre de Commandement du Réseau*, or CECOR).

In August 2003, the French defense procurement agency announced a 100 million Euro plan to upgrade the RITA 2000 system with new hardware and software to provide state-of-the-art tactical Internet and mobile communications services.¹⁷

For tactical communications, France currently uses older versions of the PR4G radios, although several units have begun using newer versions, which include features such as advanced encryption (frequency hopping), voice and data multiplexing, a built-in Global Positioning System (GPS), and tactical Internet capabilities. The Tactical Local Area System (LAS) developed by Thales provides a tactical command post in the field with digital communications capabilities through a vehicle-mounted, IP-based system. In the French navy, several platforms, including some E-2C aircraft and the aircraft carrier *Charles de Gaulle*, possess Tactical Digital Information Link technology of the Link-11 and Link-16 types; this technology is now also installed in aircraft of the French air force.

¹⁷ *Defense News*, "Thales to Make RITA Gear," 1 December 2003, 40.

Military satellite communications (MILSATCOM) are also at an advanced stage using the Syracuse satellites produced by Alcatel Space. The current system, Syracuse 2, uses the military payloads of the Télécom 2 commercial constellation, operated jointly by France Télécom and the French armed forces. The system cannot provide global coverage, but covers all of Europe, and reaches the United States to the west and India to the east. Its satellites will begin to reach the end of their lives in 2004, and while some of them will still be available as backup, a new system, Syracuse 3, is planned to replace them. The first of these satellites, Syracuse 3a, will be placed in orbit sometime in 2004, and the second is scheduled for launch in 2006. A third satellite, which would be launched around 2010, is currently under study. The satellites will have SHF and some EHF capabilities. Several hundred airborne, terrestrial, and ship-borne satellite terminals are expected to be deployed and linked to the satellites. As things stand today, the French government will own the Syracuse 3 constellation; however, the French Ministry of Defense is beginning to consider the possibility of letting a private consortium manage the third satellite in an agreement based on Britain's Skynet 5 model.¹⁸ The Syracuse 3 satellites will form part of the British-French-Italian solution for NATO's future satellite communication needs, and France has additional agreements with Germany, Belgium, and Spain to share Syracuse 3 capacity.¹⁹

Since the year 2002, a system is also in place that provides end-to-end communications between operational units in external theatres of operation and their commanders in France. Dubbed ARISTOTE, it uses the Syracuse constellation and other available allied and commercial COMSATs to provide a broadband architecture based on the latest commercial standards. The system supports voice, telegraph, fax, and data (including tactical Internet).

Future communications projects include a future naval intranet system (RIFAN), a secure e-mail system for the French MOD (Universal Secure Messaging, or *Messagerie Universelle Sécurisée*, or MUSE), and the Airborne Laser Optical Link (*Liaison Optique Laser Aéroportée*, or LOLA), a demonstrator that in 2006 is expected to test the feasibility of high-rate laser optical

¹⁸ Peter B. De Selding, "French Defense Ministry Considers Commercial Model for Syracuse 3," *Space News*, 1 December 2003, 6.

¹⁹ C. Laurent, "Syracuse 3 – A New Generation of Military Satellites," *CNES Magazine* 12 (April 2001): 30.

links between a satellite and a UAV in flight. France also plans to procure Link-16 equipment for its Rafale aircraft and for some naval platforms.

Intelligence, Surveillance, and Reconnaissance

France is currently the European leader in deployed space-based ISR capabilities and is the primary operator of Helios 1, the only European military earth observation system currently in orbit. Despite the cancellation of the Horus radar satellite program in 1998, France continued its earth observation efforts with the development of two Helios 1 satellites; the first has been in orbit since July 1995, the second since December 1999. A joint French, Italian, and Spanish project, the Helios 1 satellites both carry optical imagers with approximately one-meter resolution and are capable of imaging any point on earth within 24 hours. A framework has been established allowing each nation to control the onboard imaging system on a pro rata basis, based on each nation's financial contribution to the program (France 78.9 percent, Italy 14.1 percent, and Spain 7 percent). The Helios 1 system allows each of the co-owners to maintain strict secrecy from each other regarding the use they make of it. However, to make optimum use of the imaging capacity, the three partner nations have agreed on certain common needs and program the satellite accordingly. Thus, more than 30 percent of the imagery taken by Helios 1 is shared between the partners. In addition to fixed ground stations for the receiving of Helios 1 imagery, France possesses at least one mobile ground station, built by EADS.

The first in the next generation of French earth observation satellites, Helios 2a, is scheduled for launch during the second half of 2004; the launch of the second satellite is expected in 2008. These satellites will carry both optical and infrared imagers. The ground segment of the Helios 2 system has an open architecture that will allow for interoperability with other imagery sources, including other satellites, reconnaissance aircraft, and drones. Users, whether in Europe or in an overseas theater of operations, will have access to a workstation connected to the main ground segments, from which they will be able to request specific tasking, perform analysis, or access an imagery archive.

France is also working on a dual-use satellite system called Pleiades, a constellation of earth observation satellites able to cover both military and civilian requirements. The constellation, to be built by EADS Astrium of France, will include two new French high-resolution optical satellites, capable of resolutions of about 60 centimeters. Other satellites linked to the constellation will be the four Italian COSMO-Skymed X-band radar satellites, designed for a resolution of less than one meter for military images, and one meter for commercial ones. The Pleiades-HR satellite is expected to be launched in 2008, with the other French contribution to the constellation being launched approximately one year later. The Italian satellites are expected to be operational by 2007.

According to an agreement signed between France and Italy in January 2001, the Italian system will be linked to the French via Optical and Radar Federated Earth Observation (ORFEO), a program designed to ensure interoperability and information sharing between the two systems. Furthermore, France will give Italy access to Spot 5 and to Helios 2 imagery. The Swedish National Space Board signed an agreement with the French Space Agency in April 2001 guaranteeing its participation in the civilian aspects of the program as well as access to some of the data collected. The most recent additions to the Pleiades program, in 2002 and 2003, are Spain's defense R&D agency INTA and the civilian space agencies of Austria and Belgium, all of which secured their industrial cooperation on Pleiades and the sharing of data acquired by the system.²⁰ An information-sharing agreement between France and Germany is also expected.

France also has its own limited aerial ground surveillance capabilities. The On-Site Radar and Investigation Observation Helicopter (*Helicoptre d'Observation Radar et d'Investigation sur Zone*, or HORIZON) consists of a modular ground surveillance radar that has a moving target indicator (MTI), but no SAR. Operational in the French Army since 2002, the system consists of four radars mounted on AS-532 Cougar helicopters and two ground stations. It provides ISR capabilities for the tactical and operational levels (a similar system was sold to the Swiss Army, and Turkey has also expressed an interest in it). Maritime ISR capabilities exist in the form of the Breguet Atlantic manned aircraft. Additional manned aerial ISR is provided by Mirage F1-CR

²⁰ The total non-French role on the Pleiades program will not exceed 15 percent. See de Selding, Peter B. "Italy, France OK Orfeo Satellite Plan". *Defense News*, 19 January 2004.

aircraft outfitted with the Raphael Side Looking Airborne Radar (SLAR) pod, an infrared pod, and the Stand-Off Reconnaissance Pod (*Pod de REconnaissance STand Off*, or PRESTO) digital camera pod, and by the navy's Super Etendard 4 aircraft carrying a camera and infrared and radar pods.

France also deploys four Airborne Warning and Control System (AWACS) E-3D aircraft, built by Boeing and delivered to the French air force between 1991 and 1992. In 1998, France began upgrading these aircraft to outfit them with Boeing's Electronic Support Measures (ESM) system. This system provides the E-3D with passive listening and detection capabilities, which enable it to detect, identify, and track electronic transmissions from ground, airborne, and maritime sources.

France also leads Europe in deploying surveillance and reconnaissance UAVs. For medium-altitude, long-endurance (MALE) missions, the Hunter and Eagle-1 systems are currently being field tested by the French air force, with an operational squadron envisioned by the end of the year 2005.²¹ Approximately five systems are currently being tested, with air vehicles carrying Synthetic Aperture Radar (SAR) and MTI radar, TV cameras, Forward-Looking Infrared (FLIR), and a satellite data link. For tactical, short-range missions, a number of smaller systems are deployed. The Crecerelle (Kestrel) has been deployed by the army since 1995, and has been successfully operated as part of French NATO operations in the Balkans. Recently, a communications-jamming version has also been deployed. The Crecerelle is outfitted with a TV camera and optical and infrared sensors, and is expected to be operational until 2004. Another system in use by the army at corps- and division-level for tactical reconnaissance missions, and successfully deployed in the Balkans, is the CL-289, codeveloped with Germany (originally by Aerospatiale and Dornier, now EADS). Operational since 1993, its payload is usually limited to black and white cameras and infrared sensors. A separate program known as Reconnaissance Vehicle Programming, Interpreting, and Displaying (*Programmation, Interprétation, Visualisation d'Engins de Reconnaissance*, or PIVER) was undertaken to develop its ground stations. Finally, the Pointer hand-launched UAV system, manufactured by the

²¹ The Hunter is not the TRW variant used by the U.S. Army, but a version codeveloped by Israeli Aircraft Industries and EADS. The Eagle-1 system is based on the Heron, also by IAI, and modified by EADS.

American company Aerovironment and in use with the U.S. Army, Marines, and Special Forces, was granted an export license by the United States in 2001, and several systems have already been delivered to the French army.

The French army is also planning for the next generation of tactical UAVs. The army's Intermediary Tactical Drone System project (*Systeme de Drone Tactique Intermediare*, or SDTI) for the replacement of the Crecerelle UAVs began in February 2003 with the development of a Sagem UAV derived from the Sperwer; the first trial flights were undertaken in December 2003. Eighteen vehicles (outfitted with a black-and-white camera and an infrared sensor) and four ground stations are expected to be purchased, capable of interoperating with the French Atlas, Martha, and SICF C2 systems. The system is expected to be fully operational by December 2004. For longer-term needs, the or Multi-Collector, Multi-Mission program (*Multi Capteurs, Multi Missions*, or MCMM) has been underway since September 2002. MCMM will provide for the army's UAV needs beyond the year 2008, when the CL-289 and SDTI systems are expected to go out of service. The French Air Force is beginning the R&D of the next generation of MALE UAVs under project EuroMALE, planned for deployment between 2008 and 2010. In May 2002, the Netherlands air force announced that it would collaborate with France on this program, and by 2004 Sweden, Italy, Switzerland, the United Kingdom, and Spain had also expressed their interest in joining.

Work is also being undertaken on a French unmanned combat aerial vehicle (UCAV), dubbed Neuron, to be developed by Dassault (in collaboration with EADS) and operational by 2009. Sweden (Saab) and Greece (Hellenic Aerospace) will be partners in this program, and other European countries are currently interested. Lastly, a tactical rotor-wing UAV, built by ECT Industries of France, is currently under development for the French Navy. The first prototype of this project, dubbed Helicopter Operated from Afar (*Hélicoptère Téléopéré*, or HETEL), was flown in December 2002, and trials are expected to begin in 2005. Plans are also in place for the development of a long-endurance maritime UAV.

For online management of both mission and support data from geographical and intelligence sources and databases, France has deployed the Multi-Source Interpretation

Assistance System *Système d'Aide à Interprétation Multicapteur*–SAIM). This is an imagery intelligence analysis system that uses data fusion techniques to create an all-digital image chain for imagery from sensors (satellites, air, sea, and ground radars) enabling some interoperability with national and allied intelligence systems. It is in service with the French Air Force, Army, and Navy, and was used during recent conflicts and multinational exercises (where it proved its interoperability with the Canadian observation satellite Radarsat-1, the U.S. Joint Surveillance Target Attack Radar System (JSTARS) system, and the French HORIZON system). For the exploitation of available imagery for special operations and missile targeting, a separate system exists, the TIPI3D system, which translates imagery into 3D graphic models. Two TIPI3D are known to be currently deployed.

In addition to systems for the collection of imagery intelligence and for surveillance and reconnaissance missions, France possesses a number of collection and analysis capabilities for other types of intelligence. Airborne SIGINT gathering and analyzing capabilities (for both communications and electronic intelligence) have existed since the 1980s. Two Gabriel systems, mounted on C-160 transport aircraft, are currently deployed. More recently, airborne SIGINT capabilities have been upgraded with the introduction of the Airborne Electronic Warfare Information Collection System (*Système Aéroporté de Recueil d'Informations de Guerre Electronique*, or SARIGUE) in 2001. Currently, one such system, carried by a DC-8 airplane, is known to be operational.

The French armed forces also deploy terrestrial and naval SIGINT and electronic warfare capabilities. The French army deploys the Forward Electronic Warfare System (*Système de Guerre Electronique de l'Avant*, or SGEA) as well as other mobile electronic warfare and SIGINT collection systems. The French navy possesses several vessels carrying SIGINT equipment, and is planning to deploy its newest naval program, the Joint Forces Electromagnetic Research program (*Moyen Interarmées de Recherches Electromagnétiques*, or MINREM), on a new vessel in 2005.

Since the mid-1990s, France also possesses space SIGINT systems. Initially, two micro-satellites, Cerise (Cherry) and Clementine, were piggybacked on Helios 1 satellites in 1995 and

1999. An additional signals interception system, dubbed Euracom, was also piggybacked on the first Helios 1 satellite. While these systems were intended mainly as pilot projects, they are due to be complemented in 2004 by a cluster of four Essaim (Swarm) micro-satellites specializing in Communications Intelligence (COMINT), to be piggybacked on the first Helios 2 satellite.

Table 2 . French C4ISR capabilities

	Deployed today	Deployed by 2005	Deployed after 2005	Interoperability
C2				
Système d'Information et de Commandement des Forces (SICF)	Army division-level (including overseas task forces)			Compliant with NATO STANAGs; will be interoperable with future French tactical UAV (SDTI)
Système d'Information Régimentaire (SIR)	Army company-level (redirected from regimental-level in 2001)			Compliant with NATO STANAGs
Système d'Information Terminal (SIT)	Army tactical-level			
Martha	Air defense			Will be interoperable with future French tactical UAV (SDTI)
Système de Commandement et de Contrôle des Opérations Aériennes (SCCOA)	Air force			Will be interoperable with NATO ACCS
Atlas	Artillery			Interoperable with U.S., United Kingdom, Italian, and German surface-to-surface firing systems and with SIR; will be interoperable with future French tactical UAV (SDTI)
Système d'Exploitation Navale des Informations	Navy (installed on frigates and aircraft)			

Tactiques (SENIT)	carriers)			
Cooperative Engagement Capability (CEC)	Several systems deployed on navy ships			Interoperable with U.S. and Royal Navy ships
Project C2H		C2 system for air force helicopters		
SIC21		C2 system for navy		
Système d'Information et de Commandement des Armées (SICA)		Cross-service C2 system for joint warfare		
Communications and Computers				
Système Opérationnel Constitué des Réseaux des Armées pour les Télécommunications (SOCRATE)	Communications infrastructure serving all French armed services			COTS-based ATM switching
Réseau Intégré de Transmissions Automatiques (RITA) 2000	Communications switching platform			
Syracuse 2	2-satellite military communications constellation			
ARISTOTE	End-to-end communications between operational units in external theaters of operation and their commanders in France			
Link-11, Link-16	Installed on several navy vessels and air force aircraft			Link to allied vessels and aircraft

Syracuse 3		3-satellite military communications constellation		Capacity-sharing agreements with Germany, Belgium and Spain
IP networked PR4G			VHF tactical radios used in man-portable, vehicle- or aircraft-mounted configurations	
RIFAN (future naval intranet system)			Future naval intranet system	
Messagerie Universelle Sécurisée (MUSE) (secure e-mail system for French MOD)			Secure e-mail system for MOD	
Liaison Optique Laser Aéroportée (LOLA)			High-rate laser optical links between a satellite and a UAVs	
ISR				
Helios 1	High-resolution (approx. 1 meter) earth observation satellites; optical capabilities only			Imagery sharing agreements with Italy and Spain
CL-289	Tactical, corps- and division-level recon and target acquisition UAV			
Crecerelle	Tactical, short-range UAVs deployed by army			Deployed in the Balkans in NATO operations
Pointer	Hand-launched tactical UAV system			Identical to system deployed by U.S.
Horizon	Heliborne ground surveillance radar (MTI only) for tactical and operational level			

Breguet Atlantic 1150 manned aircraft	Maritime S&R capabilities			
AWACS E-3D	Four aircraft operational			Equipped with Link-16
Mirage F1-CR and Super Etendard 4	Carry cameras, infrared sensors and radar pods			
Système Aéroporté de Recueil d'Informations de Guerre Electronique (SARIGUE)	SIGINT system deployed on a DC-8 aircraft; one such aircraft deployed			Used in support of coalition operations during Desert Storm and on NATO peacekeeping missions in Kosovo
Gabriel	SIGINT system deployed on C-160 transport aircraft; 2 such aircraft deployed			Used in support of coalition operations during the Desert Storm and on NATO peacekeeping missions in Kosovo
Système de Guerre Electronique de l'Avant (SGEA)	Intelligence and EW system for land forces			
Système d'Aide à l'Interprétation Multicapteur (SAIM)	IMINT system able to create an all-digital image chain for imagery from sensors (satellites, air-, sea- and ground radars)			Proven interoperability with Canadian observation satellite Radarsat-1, U.S. JSTARS, and French Horizon AGS
Cerise, Clementine & Euracom	Micro-satellite demonstrators for SIGINT collection			
Helios 2		Next generation earth observation satellite; IR and optical IMINT capabilities		Access to imagery from Italian COSMO and German SAR-Lupe systems in exchange for Helios 2 imagery

Systeme de Drone Tactique Intermediare (SDTI)		Next generation of tactical UAVs		Will be interoperable with Atlas, Martha and SICF C2 systems
ESSAIM		Constellation of 4 COMINT satellites		
Moyen Interarmées de Recherches Electromagnétiques (MINREM)		Ship-based COMINT and ELINT system		
Future MALE reconnaissance UAVs for air force			Possibly based on the Hunter or Eagle models	Codeveloped with the Netherlands
PLEIADES			Two earth observation satellites with a resolution of approx. 60cm	Imagery sharing with Belgium, Spain, Italy, Austria, Sweden and Germany
Multi Capteurs, Multi Missions (MCMM)			Future army UAV	
UCAV program			Under development by Dassault	Collaboration with Sweden
Hélicoptère Téléopéré (HETEL)			Tactical rotor-wing UAV for the French Navy	
Moyenne Altitude Longue Endurance (MALE)			Next-generation MALE UAV for air force	Collaboration with Netherlands, Sweden and Spain

United Kingdom

The British military have consciously embraced the concept of network centric operations, developing their own approach and coining their own phrase: Network Enabled Capabilities (NEC). This approach does not seek to create a universal network via a single technical solution. Rather, a network of networks is envisioned, in which a number of nodes, carried by deployed operational assets, are interlinked. The NEC emphasis is on “the ability to collect, fuse and analyze relevant information in near real-time so as to allow rapid decisionmaking and the rapid delivery of the most appropriate military force to achieve the desired effect.”²² NEC will improve current sensors that gather information, build the network for fusing and communicating the information gathered, and link the network to strike assets that can act upon the information collected. As an investment priority, NEC compatibility will be built into current and future military platforms.

Using the NEC network of networks concept, some parts of the battlespace will be linked through a C4ISR backbone using the Skynet satellite constellation and the Bowman and Falcon networks. In other parts, the network will be made up of different communications systems optimized for operating in particular environments (e.g. air to air communications, land communications). While all assets will have to possess some communications capability, only a few will need to be a permanent and integral part of the network; the rest will plug into it via specific permanent nodes.

Interoperability is a critical element of the British NEC concept. A key challenge for NEC is to keep abreast of other transformation processes occurring within the armed forces of potential allies, most notably the United States. Through relatively frequent upgrading C2 and communications technologies, somewhat easier procurement procedures, and constant participation in U.S. defense R&D programs, the British armed forces today have the highest level in Europe of interoperability with American forces. The Royal Navy and Royal Air Force, however, have a higher level of interoperability with their American and European counterparts than does the British Army.

²² United Kingdom Ministry of Defence, *Delivering Security in a Changing World: Defence White Paper*. (Norwich: HM Stationery Office, 2003), 11.

In the near term, delivering NEC means identifying options to modify existing systems. Delivery in the medium term will require intervening in programmed equipment to ensure that delivered systems are capable of exploiting the information they collect and/or receive. Over the long term, the procurement program is to deliver platforms and systems which are net ready.

The MOD has been structured to emphasize Britain's commitment to NEC. NEC currently falls under the Directorate for Equipment Capability–Command, Control and Information Infrastructure (DEC-CCII), headed by a one star general. DEC-CCII is the largest equipment capability area in MOD, responsible for delivering solutions to C2 and IT gaps in British military capability. DEC-CCII is able to balance funding across programs and between other DEC's to deliver operational capability.²³

The United Kingdom has also formulated a doctrine to integrate the British C2 and communications infrastructures into a single Defense Information Infrastructure (DII). DII will, in effect, incorporate the Joint Operational Command System (JOCS) C2 system, the Bowman communications system, and other individual information systems into a single information infrastructure. DII is currently in the prequalification stage, and the British MOD has invited four industry teams to submit their outline proposals for its delivery.²⁴

As part of the NEC effort, the British MOD is also making considerable investment in the development and deployment of new sensors systems. The largest and most recent ISR R&D and acquisition programs include the Watchkeeper UAVs, the Airborne Stand Off Radar (ASTOR) airborne battlefield surveillance system, and the Soothsayer electronic warfare system. Additionally, several sensor platforms already operational, such as the Phoenix UAVs and the Jaguar and Tornado reconnaissance aircraft, are being upgraded to include more advanced and

²³ The other Core Capability DEC's at MOD are DEC ISTAR (responsible for Intelligence, Surveillance, Target Acquisition, and Reconnaissance), DEC TA (for Air Enablers) and DEC NBC (for Nuclear, Biological, Chemical warfare).

²⁴ The first team comprises EDS, Fujitsu, Cogent, General Dynamics, and LogicaCMG. The second is made up of IBM, BAE Systems, Computacenter, Steria, ntl, and Echelon. The third includes Lockheed Martin, Deloitte Consulting, Hewlett Packard, QinetiQ, SAIC, and Unisys. The fourth is made up of CSC, British Telecom, CGEY, and Thales. The DII system is expected to be delivered around 2007.

integrated ISR suites. Overall, the networking of sensors from air, land, and naval systems using data fusion techniques is at a very advanced stage.

In addition, in August 2003, MOD created the Network Integration Test and Experimentation (NITE). Dubbed NITEworks, this MOD—industry partnership provides an environment for the assessment and demonstration of the benefits of NEC and the options for its effective and timely delivery. On the industry side, the NITEworks partnership includes BAE Systems, QinetiQ, Alenia Marconi Systems (AMS), EDS United Kingdom, Thales United Kingdom, General Dynamics United Kingdom, and Raytheon United Kingdom. Key system integration and interoperability issues will be resolved through testing, experimentation, and evaluation of various NEC options. Eventually, NITEworks plans to identify opportunities for changes in defense R&D and procurement programs.

Command and Control

The Royal Navy, Royal Air Force, and Army currently deploy separate C2 systems; these are not interoperable across services. Since 1995, the Army has deployed the JOCS, designed to pass information between the Permanent Joint Headquarters (PJHQ) and the Joint Forces Headquarters (JFHQ), the Joint Rapid Reaction Force (JRRF) headquarters, and other headquarters of joint and potentially joint operations. It thereby allows the PJHQ to maintain a joint operations picture of deployed forces, comprising maritime, land, and air activities within certain areas. The system is deployable, and can operate over MOD provided Wide Area Network (WAN) connections as well as a range of civilian infrastructures while employing the appropriate cryptography. Work is also underway to harmonize JOCS with the U.S. Global Command and Control System. Today, JOCS has become the basis for defining and developing a more capable system, the JCS. Under JCS, plans are in place to integrate the Army's C2 system with those of the other services—most importantly, the Royal Navy's Command Support System (CSS) and the Royal Air Force's Command, Control, and Information System (CCIS) (see below)—using state-of-the-art commercial technologies under the DII project.

The Royal Air Force deploys the CCIS for aerial C2 and the Air Defense Ground Environment (ADGE) system for tactical control of air defense operations. A deployable system for the support of RAF missions both in the United Kingdom and overseas, the Collaborative System for Air Battlespace Management (CSABM), is currently under development; it is expected to be fielded by the year 2008. Additionally, the Backbone Air Command and Control System (BACCS) is currently under development as the British air defense system of the future, although the design concept requires it to be fully interoperable with NATO air defense capabilities (the NATO ACCS program—see below - will provide the core BACCS software and infrastructure on which the system capability will be based). BACCS is due to enter operational service with the RAF from 2009.

The Royal Navy possesses the CSS, which replaced the more outdated Fleet Operational Command System (FOCSLE) and currently provides C2 information to the Command Teams of ships, submarines, and the Royal Marines 3^d Commando Brigade. The system supports, among others, situation awareness data, message handling, and several decision and planning aids for amphibious operations. Additionally, the Navy is currently working to install several CEC systems on several frigates. This is a U.S. naval air defense and fire control system that enables ships to share the battlefield picture. The Royal Navy has also installed the American Collaboration at Sea (C@S) tactical maritime C2 system on several vessels. This system uses leased bandwidth on commercial satellites (mainly INMARSAT) to transmit a common battlespace picture to all vessels and the naval headquarters to which it is linked.

On a broader international level, the United Kingdom is currently working with the United States, Canada, Australia, and New Zealand to link their respective C2 systems via a coalition WAN and web server. This collaborative program is undertaken as part of the Multinational Interoperability Council (MIC) framework, and will most likely be broadened to include France and Germany (see Appendix).

Communications and Computers

The British Army currently fields Ptarmigan, a tactical trunk network, linking all headquarters in the field. The system was upgraded in early 2003 with the introduction of 30 vehicle-mounted units providing improved data access to mobile subscribers and enabling deployment independent of main Ptarmigan trunk networks. Ptarmigan currently enables interoperability with U.S. or NATO forces through interfaces with specific systems. In 2006, it will be replaced by the fully digital Falcon network. Falcon is planned to be interoperable with Bowman, Skynet, and various NATO communications systems.

Bowman, the next-generation tactical combat VHF radio network for all British services, began deployment in July 2003, and was accepted into service by the MOD in March 2004. This new infrastructure replaces the 20-year-old Clansman system and the Headquarters infrastructure element of the Ptarmigan trunk communications system. It provides Britain with an integrated network supporting digital voice and data for radio, telephone, intercom and tactical Internet information in a single system. As part of the Battlefield Land Digitization (BLD) program (battlefield information systems being developed for armored fighting vehicles, artillery fire control, air, and nuclear, biological, and chemical defense), Bowman will be used as a communications and C2 infrastructure from fighting platform up to divisional level. Full deployment is expected by 2006-2007, when some 20,000 military vehicles, 156 ships and 276 aircraft will be outfitted with more than 46,500 radios and 26,000 computer terminals. However, Bowman will face bandwidth limitations, as well as the problem of being digital but lacking a software communications architecture (SCA). Since this would make it hard to interoperate with the U.S. Joint Tactical Radio System (JTRS), the U.S. program is being adapted to enable it to handle the Bowman waveform.

A fully transportable United Kingdom communications network exists for expeditionary forces, linking them back to headquarters in Britain. The Cormorant system is provided by Cogent (jointly owned by EADS and Nortel) and is intended to meet the communications requirements of the United Kingdom's JRRF headquarters in any theater of operations. It is

linked to the Ptarmigan (and, at a later stage, will also be linked to Bowman) tactical radios deployed by the JRRF troops.

MILSATCOM capabilities currently use the Skynet 4 constellation. Two of the first three satellites launched between 1988 and 1990 remain in service. These currently support three newer spacecraft launched between 1998 and 2001. In October 2003, the British MOD concluded arrangements to transfer the operation of the Skynet 4 system to Paradigm Secure Communications, a subsidiary of EADS. Under this Private Finance Initiative (PFI), Paradigm will also upgrade, by 2005, the two main Skynet 4 ground stations to increase bandwidth and refresh technology. Paradigm will also manage the leasing of commercial SATCOM bandwidth for MOD. The deal, which will run until 2019, features service delivery arrangements that provide high assurance to MOD, while permitting Paradigm to resell unused bandwidth to the governments and militaries of other nations under commercial arrangements. To maintain services to MOD and to its other customers, Paradigm will develop, launch, and operate two to three new satellites built by Astrium (also an EADS subsidiary).²⁵ The first of the new Skynet 5 satellites is expected to enter service in 2007. Both the existing and new Skynet satellites remain accessible via MOD's existing fleet of terminals. Higher bandwidths are possible with the new Talon (man-portable) and Dagger (vehicle-mounted) mobile terminals. Some 50 new Reacher mobile land terminals are also expected to be delivered soon under the Skynet 5 contract arrangements.

The Royal Air Force and Navy have installed the Joint Tactical Information Distribution System (JTIDS) Link-16 communications system on most aircraft and helicopters (including Tornado F3s, Nimrods, Sea Kings, and E-3D AWACS), and on several vessels (including carriers, frigates, and destroyers), providing these and their U.S. counterparts with a common air picture. The Royal Navy's Sea Harriers are also to be outfitted with Link-16 equipment in 2004. Many Royal Navy ships and RAF E-3D AWACS and Nimrods are also equipped with the Link-11 tactical data link system.

²⁵ *Space News*, "Skynet 5 Contract Has Built-in Safeguards," 1 December 2003, 10.

Finally, since interoperability with U.S. forces is still a major concern for British warfighters, the United Kingdom will most likely be buying American JTRS radios and installing them on various other aerial, maritime, and terrestrial platforms, at least as an interim solution for current and upcoming coalition operations.

Intelligence, Surveillance, and Reconnaissance

British UAV capabilities currently consist almost solely of the Phoenix tactical, short-range UAV, used by the Royal Artillery for reconnaissance and target acquisition.²⁶ The system has been in service since 1998. Though currently unable to share the information it collects directly with other British systems, improved data modems could make it interoperable with Skynet 4, RAF Tornados, and army Apaches. However, its performance, recently tested in Kosovo and Iraq, is somewhat limited even at the tactical level. Major limitations include an inability to operate in high-temperature environments, a payload consisting solely of a thermal imaging sensor, and a slow data link. In both the Kosovo and Iraq campaigns, these limitations led to the loss of a high number of Phoenix UAVs (23 were lost in Iraq, all due to technical failures—a ratio of one in six flights undertaken) and restricted it mainly to nighttime operations. However, the Phoenix was involved in what was probably the first joint close air support operation coordinated by a UAV mission controller: it was able to relay imagery and geographical details on Iraqi tank movements to U.S. fighters via its ground station.²⁷

The British long-endurance, operational-level UAV program, Watchkeeper, is being competed with two consortia, one led by Thales United Kingdom and the other by Northrop Grumman ISS International Inc. Initial deployment is scheduled for 2006. The program requirements call for an A and B vehicle, the former for battlefield surveillance, targeting, and bomb damage assessment and the latter for close-in surveillance and target identification. Depending on the consortium chosen to develop this program, Watchkeeper will include either the Hermes 450 and Hermes 180 (manufactured by Silver Arrow of Israel, collaborating with

²⁶ Britain has recently purchased Lockheed Martin's Desert Hawk and Mission Technologies' Buster, both mini-UAVs for very short-range reconnaissance missions.

²⁷ Andrew Chuter, "UK Strike Chief Notes UAVs' Shortcomings," *Defense News*, 4 August 2003, 8.

Thales) or the Fire Scout (manufactured by Northrop Grumman) and Ranger (by RUAG Aerospace of Switzerland) as A and B vehicles, respectively.

In addition to the Watchkeeper program, the United Kingdom is collaborating with the United States to develop the Advanced Joint Communications Node (AJCN). Once integrated into the Watchkeeper UAVs, it will provide a communications and electronic warfare system that can be reprogrammed in flight. Based on software radio technology, the AJCN will be linked to the UAV ground stations via a Tactical Common Data Link (TCDL). This will create a network comprising the different types of Watchkeeper UAVs, and tactical radios—such as the American JTRS—that are also reprogrammable.

In early 2004, pending Watchkeeper development, the British MOD began discussing an Urgent Operation Requirement (UOR) for another UAV system to be fielded within a short timeframe. The system would be used for ISR missions by British troops in Iraq. MOD reviewed purchasing or leasing the U.S. Predator and the Thales-IAI Hermes systems, as well as the Desert Hawk micro-UAV (Lockheed Martin).²⁸ To date, several Desert Hawk and one Buster micro-UAV systems (two vehicles and one ground control station from Mission Technologies Inc.) have been acquired.

In addition to the Urgent Operation Requirement and Watchkeeper, the United Kingdom is exploring other UAV solutions under the Joint Service UAV Experimentation Program (JUEP). This three-year program will assess the wider operational use of UAVs in the triservice battle environment. JUEP will include developing viable concepts of operations for UAVs, exploring the utility of UAVs for maritime operations, and exploiting new types of UAV payloads (including those giving the vehicle offensive capabilities).²⁹ JUEP may also include a demonstration of the Global Hawk UAV.³⁰

²⁸ Andrew Chuter, “UK Military Shops for Surveillance UAV,” *Defense News*, 19 January 2004. [page #].

²⁹ For a more detailed overview of the Watchkeeper and JUEP programs, see N. Fiorenza, “UK’s Leap Into UAVs,” *Intelligence, Surveillance, and Reconnaissance Journal* 2, no. 3 (May-June 2003), [page #].

³⁰ Andrew Chuter, “UK Wants Global Hawk Demonstration,” *Defense News*, 12 January 2004, [page #].

The United Kingdom also possesses unmanned underwater ISR capabilities with the deployment, in 2002, of the Marlin Unmanned Underwater Vehicle (UUV). Developed by BAE and QinetiQ, the Marlin is an electrically powered vehicle intended to be launched from a submarine torpedo tube. It is fitted with seabed imaging sensors, although the design is modular, allowing for alternative future payloads.

Britain also currently deploys several manned aerial ISR platforms, including four Canberra PR-9 aircraft for photoreconnaissance missions and eighteen Nimrod MR2 maritime patrol aircraft. Most Nimrods are equipped with magnetic and acoustic detection equipment (three are outfitted for SIGINT collection missions) and are interoperable with U.S. Rivet Joint aircraft. An upgrade (Nimrod MRA4) will make some of them capable of both maritime and land surveillance missions. The upgraded Nimrod aircraft are due to enter into service around 2006, at which point those that were not upgraded will be taken out of service.

The Royal Air Force's Jaguar and Tornado fighters provide additional ISR capabilities. The former have been outfitted since 2000 with the Jaguar Replacement Reconnaissance Pod (JRRP), with both electro-optic and infrared sensors that can record digital images onto videotape. Several of the latter have been fitted with the Reconnaissance Airborne Pod for Tornado (RAPTOR), operational since the fall of 2002. This new technology provides an electro-optical and infrared camera system that can capture high-resolution digital imagery of targets at any time of day and transmit the data to ground stations in near-real time.

For air-ground surveillance and reconnaissance, the United Kingdom is developing the ASTOR, providing strategic long-range, all-weather theater surveillance and target acquisition capabilities. Raytheon is the prime contractor for ASTOR. Five systems will be produced and deployed on modified Bombardier Global Express business jets, along with two portable ground sites and six tactical ground stations mounted on trucks. Deployment is expected in 2005. Dissemination of data to allied forces will be via United Kingdom headquarters only, and few direct links are currently expected to allied systems (though an interim solution for interoperability with the U.S. JSTARS system may be through deploying JTRS on the ASTOR platform). ASTOR also was the basis for one of the two proposed NATO Alliance Ground

Surveillance (AGS) solutions, presented by British Aerospace and Raytheon (an option rejected by NATO). Additionally, the United Kingdom deploys seven E-3D Sentry AEW-1 AWACS aircraft for air-picture management. The Sentry aircraft are all equipped with the U.S. JTIDS, and can interoperate with U.S. and NATO AWACS systems, with Rivet Joint and E-P3 aircraft, and with the British Nimrod aircraft.

As of 2006, when the Canberra planes leave service, the United Kingdom will have no assets that can loiter over the battlefield and deliver a constant stream of data for extended timeframes; nor does the United Kingdom have a program to obtain such persistent surveillance capabilities. The MOD is considering various options, including high-altitude, long-endurance (HALE) UAVs, satellites, and manned platforms. In 2004, the Tactical Optical Satellite (TOPSAT) earth observation micro-satellite (led by Surrey Satellite Technology Ltd.) will be launched as part of a pilot program to demonstrate space-based ISR capabilities and their link to commanders on the ground via stationary as well as mobile ground stations. If it performs well, TOPSAT could lead to the launching of a constellation of satellites to fulfill this need.

The British intelligence analysis and dissemination systems in place, including the RAF's Lychgate system—which connects intelligence staffs at HQ RAF Strike Command, the MOD, other services, and front-line squadrons—and the intelligence community's web-based United KingdomINTELWEB, are currently not directly interoperable with allied systems. However, the United Kingdom is part of the Integrated Broadcast Service (IBS) network, which uses commercial off the shelf (COTS) hardware to exchange information with the intelligence dissemination system of the United States, Canada, and Australia. Additionally, the GRIFFIN TCP/IP-based WAN provides a classified electronic information-sharing environment for collaborative planning activities between the strategic and operational level headquarters of Britain, Canada, Australia, New Zealand, and the United States. In the future, Germany and France may also be linked to GRIFFIN.

Table 3 - United Kingdom C4ISR capabilities

	Deployed today	Deployed by 2005	Deployed after 2005	Interoperability
C2				
Joint Operational Command System (JOCS)–Stage 1	Strategic-, operational- and tactical-level army C2 system			Links PJHQ, JFHQ, JRRF headquarters, and other HQs of joint and potentially joint operations; work is underway to harmonize JOCS with the U.S. Global Command and Control System
Command Control and Information System (CCIS)	RAF aerial C2 system			
Air Defense Ground Environment (ADGE)	Tactical control of air defense operations			
Command Support System (CSS)	C2 for Command Teams of ships, submarines and the Royal Marines 3 rd Commando Brigade			
Cooperative Engagement Capability (CEC)	Naval air-defense and fire control C2 system; deployed on several UK frigates			Interoperable with U.S. system
Collaboration at Sea (C@S)	Tactical maritime C2 system			Enables interoperability with U.S. vessels
Joint Command System (JCS) (stage 2 of JOCS)		Integration of the C2 systems of all three services		All 3 services at national level
Collaborative System for			Deployable system to	Will be interoperable

Air Battlespace Management (CSABM)			support RAF mission both in the United Kingdom and overseas; deployed by 2008	with other UK systems
Backbone Air Command and Control System (BACCS)			Future Air Defense C2; deployed by 2009	Full interoperability with NATO air defense systems
Communications and Computers				
Ptarmigan	Tactical trunk communications system for army HQs in the field			Interoperability with some U.S. and NATO systems
Skynet 4	MILSATCOM system; Talon (man-portable) and Dagger (vehicle-mounted) mobile satellite terminals			
Cormorant	Transportable, secure telecommunications network linking task force HQ with UK HQ			Linked to Ptarmigan and Bowman units fielded by RFF
Joint Tactical Information Distribution System (JTIDS) / Link-16 are to be outfitted with Link-16	Installed on RAF Tornado F3s, Nimrods, Sea Kings and AWACS, and on RN carriers, frigates, destroyers and Sea Harriers			Enables common air picture with U.S. aircraft and vessels
Bowman		Tactical combat radios network for all services; first units tested July 2003, full deployment by 2006-8		Interoperable across services (any military VHF radio) only in unencrypted mode; partly interoperable with

				U.S. JTRS
Skynet 5			Future MILSATCOM system; leased capacity from 3 commercial satellites; entry into service in 2007; Reacher (mobile land terminals)	
Falcon			Future (replacing Ptarmigan) UK-to-campaign theater tactical trunk communications system; planned for deployment in 2006	Interoperable with Bowman, Cormorant, Skynet 5, NATO communications systems
ISR				
Phoenix	Tactical target acquisition UAV for the army (artillery corps)			Little interoperability with other systems; possible upgrades will make it interoperable with Skynet 4 and with RAF Tornados and army Apaches
Desert Hawk / Buster	Micro-UAV systems for Army			Same as those deployed by U.S. army
Marlin	UUV			
Canberra aircraft	Tactical aerial photoreconnaissance			
Nimrod	Maritime S&R and SIGINT aircraft			Interoperable with USAF Rivet Joint aircraft
Jaguar and Tornado fighters	Equipped with JRRP and RAPTOR ISR pods			
E-3D Sentry (AWACS)				Interoperable with U.S. and NATO AWACS

				systems, U.S. Rivet Joint and E-P3 aircraft, and British Nimrod aircraft
Lychgate	Intelligence analysis system for RAF			Connects intelligence staffs at HQ RAF Strike Command, the MOD, other services and front line squadrons
UKINTELWEB	Web-based intelligence dissemination system at various security levels, in support of the Intelligence community			British intelligence community only; not interoperable with other countries
Integrated Broadcast Service (IBS)	Intelligence data dissemination system for up to T/S material			Interoperable with similar systems in U.S., Canada, and Australia as well as with other British intelligence systems
GRIFFIN	TCP/IP-based WAN for intelligence data sharing between strategic and operational level headquarters			Links United Kingdom, Canada, Australia, New Zealand, and U.S.; in the future, Germany and France will also be linked
Airborne Stand Off Radar (ASTOR)		Strategic long-range, all-weather theater surveillance and target acquisition capabilities; begin deployment in 2005		May be interoperable with U.S. J-STARS; dissemination of data initially via United Kingdom only
Tactical Optical Satellite		S&R micro-satellite for		

(TOPSAT)		remote sensing; launch planned for 2003-2004		
Watchkeeper			Future operations-level UAV; to be deployed in 2006	A TCDL will enable interoperability between the two types of Watchkeeper UAVs
Joint Service UAV Experimentation Program (JUEP)			Wider operational use (including weaponization) of UAVs in the tri-service battle environment	May also include demonstration of Global Hawk HALE UAV

Germany

While the German military deploys a variety of C4ISR technologies, it is moving only slowly toward an advanced, networked architecture. Germany began to address the concept of network centric warfare only recently; hence, few major acquisition or R&T programs are underway. Moreover, during the next ten years, previously planned key hardware programs such as the Eurofighter Typhoon, A400M transport, and Tiger and NH-90 helicopters, will consume the lion's share of German defense acquisition resources. Few large-scale C4ISR expenditures are expected, save an investment of €180 million for new communications technologies. Overall, spending on defense R&D is expected to decline by almost 9 percent between 2003 and 2004.³¹

Recent military planning suggests Germany is now focused on the goal of greater network centric capabilities. Policies announced in 2003 will lead to a downsizing of the armed forces by 35,000 troops, 10,000 civilians, and between 100 and 200 bases by 2007. The German force will be divided into three categories, reflecting a move away from a doctrine of massive land warfare on the nation's borders to global expeditionary operations in coalitions. The first category, some 35,000 troops, will become reaction forces capable of participating in high-intensity combat operations. These forces will field state-of-the art C4ISR technologies for network centric operations and interoperability with allies. The second category, approximately 70,000 troops, will be peacekeeping forces with less-advanced C4ISR capabilities. The third category, roughly 135,000 troops and 70,000 civilians, will provide support for the first two. While no cancellation of platform procurement programs is foreseen, money saved through downsizing of forces and a change in defense doctrine may bode well for Germany's future C4ISR capabilities and its ability to interoperate with allies.

Current German C4ISR capabilities do not yet include a cross-service C2 architecture, nor have broadband communications been widely deployed. Germany has begun embracing UAVs, especially since the Balkan and Afghanistan experiences. The German military is currently equipped with only a small number of UAVs for tactical and operational missions, and funding for a major UAV program is not yet firm (several programs have been canceled). The

³¹ Martin Agüera, "Decline in German Research Continues," *Defense News*, 6 October 2003, 32.

outlook for the HALE Euro-Hawk system, however, is positive. Once it comes into service, it is expected that outdated manned platforms for ISR will be scrapped and Germany will become increasingly reliant on unmanned ISR capabilities.

Germany has been a member of the binational German-Netherlands Corps since 1995. Between 2000 and 2002, the Corps became a NATO High Response Force, under operational command of SACEUR. This Corps has slightly more advanced C4ISR capabilities, including the German HEROS C2 system, the Dutch TITAAN communications infrastructure (VoIP WAN with SATCOM and HF radio), and Sperwer tactical UAVs procured from France.

Command and Control

The Bundeswehr C2 systems serve the individual services but lack a common infrastructure. The German army is beginning to deploy the HEROS (*Heeres-Führungsinformationssystem für die rechnerunterstützte Operationsführung in Stäben*, or Army Command and Control System for digitally-supported Command of Operations in Staffs) system which provides C2 for corps, division and brigade levels. HEROS is an IP-network based infrastructure for data transmission and can be fixed or mobile. It has been fielded in one division of the army, with a second division to be fielded soon. HEROS is also deployed with EUROKORPS and, as previously mentioned, with the German-Netherlands Corps.

For regiment-level C2 and below, the German army has begun to deploy the FAUST (*Führungsausstattung taktisch*, or Tactical Command Provision) system, which includes mobile modules mounted on armored personnel carriers. Currently fielded only in small numbers (with German forces in KFOR, Kosovo, and ISAF, Afghanistan), FAUST is expected to be fully deployed over the next year or so.³² Additionally, the army's tanks and armored vehicles designated for overseas deployment are outfitted with the Mobile Command and Control System (MCCS). MCCS hardware is based on a COTS notebook with integrated communication interfaces, GPS, and compass unit as well as C2 software developed by STN Atlas (now

³² For more information on FAUST and HEROS, see: *Wehrtechnik* 1 (2003), 66-67.

Rheinmetall Defence Electronics). Several such systems are currently operational with the German forces in Kosovo and Afghanistan.

The German Navy uses a C2 system called MHQ (marine headquarters). This IBM mainframe-based infrastructure links all headquarters into a single network. Additionally, all ships in the German Navy use the Maritime Command and Control Information System (MCCIS) and the C@S tactical C2 system purchased from the United States. This enables all German Navy vessels not only to be fully linked between each other and with their various headquarters, but also makes them interoperable with many ships in the U.S. Navy that carry similar C2 equipment.

The German Air Force uses the EIFEL C2 system, an IP-based infrastructure that has recently been upgraded to incorporate the whole service (the system is also known as the GAFCCIS—German Air Force Command and Control Information System). Other C2 networks that are unique to specific units of the German armed forces include the artillery corps' ADLER and the air defense systems' HflaAFüSys. Finally, the armed forces command is linked to the German Ministry of Defense via RUBIN, an IP-based, stationary system for high-level C2.

The German army is planning to deploy a more network-oriented C2 infrastructure. Known as FüInfoSys H, this system will integrate the FAUST and HEROS systems, which are not interoperable today. Initial deployment is scheduled for 2006. Other efforts to upgrade German C2 capabilities include development of the next generation of air defense system through the Surface-Air-Missile Operations Center (SAMOC) project, expected to be operational by the end of 2004. A C2 system integrating all services is planned under Pilot Project 9.4.4. It will eventually integrate the RUBIN, HEROS, FüInfoSys H, GAFCCIS, MHQ, and MCCIS systems.

In 2001, the German Ministry of Defense began to create a common C2 system for the armed forces of the Baltic States (Latvia, Lithuania, and Estonia) that would be interoperable with Germany's C2 systems and comply with NATO STANAGs. Known as BALTCCIS, the

project is managed by the German Air Force in collaboration with BAE Systems, and is still in the development stage.

Communications and Computers

The main tactical communications infrastructure of the German Army is the digital Automated Corps Network (*Automatisiertes Korpsstammnetz 90*, shortened to AUTOKO-90) network, built by Siemens and deployed since 2000. This network has significant shortcomings. It can deliver only limited bandwidth, cannot handle IP traffic, and uses EUROCOM, a communications standard developed in Western Europe in the 1970s as an effort to make all tactical military communications systems interoperable, but not widely deployed outside Germany. As a complement to AUTOKO-90, the army has added the BIGSTAF (*Breitbandiges, integriertes Gefechtsstand-Fernmeldesystem*, or Integrated Broadband System for Command Posts Communications) system to its communications infrastructure. Built using Thales and EADS IP and ATM technologies, BIGSTAF provides broadband communications (voice and data) for command posts at brigade, division and corps levels. However, BIGSTAF too currently only uses EUROCOM, and is therefore not interoperable with most other systems.

The German Navy has set up its own communications network, the IP-based Tactical Mobile Radio Network currently deployed on all vessels. Additionally, many navy ships are outfitted with Link-11 and other communications equipment that were seen as the quickest solution for achieving interoperability with the U.S. Navy. The German Air Force has deployed AutoFü, a communications infrastructure for all its bases. This system is also IP-based, with medium bandwidth capabilities. For tactical communications, some of the *Luftwaffe's* Tornados and NH-90 helicopters carry the Multifunctional Information Distribution System (MIDS) or are currently being outfitted with it. A program is underway to outfit all the *Luftwaffe's* Tornados and all 180 new Eurofighters with MIDS. The German Navy has also equipped two Class 123 frigates with MIDS systems.

A cross-service digital communications network, the ISDN-BW, has been deployed since the mid-1990s; it carries voice and data to all central commands. The navy and air force have

both successfully integrated their own communications infrastructures with ISDN-BW, but the army is still seeking better levels of integration.

To link expeditionary forces with allied forces, the local telecommunications infrastructure, and their headquarters, Germany has an ongoing program known as Interoperability for Crisis Reaction Forces (*Krisenreaktionskräfte–Interoperabilität*, or KINTOP). It includes the development and acquisition of mobile personal communications systems based on the TETRAPOL standard, used by various European law-enforcement agencies and currently undergoing testing in the U.S. Army. The link from theaters of operation to Germany will be via satellite, through a program known as SATCOM-BW. The first phase of the project has already been completed, and includes the leasing of C- and Ku-band capacity from commercial satellites and the procurement of 40 single- and multichannel ground fixed and mobile stations. The second phase is currently planned, and involves the building and placing in orbit of two X- and UHF-band dedicated satellites operated by the private sector. Phase 2 is expected to begin in 2005, with both satellites in orbit by 2008.³³

Intelligence, Surveillance, and Reconnaissance

Germany is currently reassessing its ISR capabilities, and planning for future research and procurement. The major issues are the replacement of the Breguet Atlantic fleet for maritime patrol, the acquisition of land-based ISR assets, and the development of an aerial battlefield surveillance capability, either manned, unmanned, or a combination.

Germany's UAV deployment is still quite limited, but the potential capabilities this technology can provide are seen as important by military planners. For tactical reconnaissance and target acquisition missions at the corps and division level, the German army uses the CL-289 UAV developed by Aerospatiale and Dornier (now EADS), which provides black and white or infrared stills imagery. The system has been used successfully in the Balkans, where it has been operational since 1998. The Taifun (Typhoon) UCAV, designed to carry radar and infrared

³³ Peter De Selding, "Foreign Firms Battle for German Telecom Sats," *Defense News*, 5 April 2004.

sensors and be able to identify and engage targets, is still in its initial phases. Development will be undertaken between 2005 and 2009, with procurement starting in 2009.

Several other German UAV programs have been canceled, largely for budgetary reasons. A project to develop a target acquisition platform, known as KZO (*Kleinfluggerät für Zielortung*, or Small Device for Target Acquisition) or Brevel, was cancelled due to lack of funds even though several prototypes were already deployed. A similar fate probably awaits the army's LUNA (*Luftgestützte Nahaufklärungs-ausstattung*, or Aerial Close-up Reconnaissance Provision) X-2000 project for the development of a tactical UAV for the artillery corps; while two prototypes of this UAV currently exist and have been flown over Kosovo (carrying video cameras only), more will probably not be produced or procured. Finally, the German SEAMOS project for the development of a vertical take-off and landing rotor system UAV has also been cancelled. SEAMOS UAVs were intended as unmanned radar platforms for Germany's new K130 corvettes.

Germany's army and navy also deploy manned airborne ISR capabilities in the form of reconnaissance pods fitted onto Germany's Tornado aircraft. The pods are outfitted with a Zeiss camera and infrared system. The Breguet Atlantic 1150 fleet performs ISR missions, mainly maritime ones. Consisting of 11 or 12 aircraft carrying MTIs, sonars and magnetic detectors, and 4 aircraft carrying SIGINT and electronic warfare suites, the fleet has been operational since 1965. Although the aircraft have undergone several rounds of upgrading, they will reach their maximum lifespan in 2010 and have therefore been scheduled for replacement. A project for R&D of the next generation of maritime patrol aircraft, initially planned to be undertaken in collaboration with the Italian armed forces, was recently cancelled. Procurement of between eight and ten used PC-3 aircraft from the Netherlands may provide an interim solution. For the longer term, however, the Germans are moving toward unmanned platforms. For maritime missions, these may consist of UAVs deployed by the German Navy on their new corvettes, with Northrop Grumman's Fire Scout and Bell Helicopter Textron's Eagle Eye two possible alternatives.

For ground-based ISR, the German army began deploying the Fennek vehicle in 2004, produced by Krauss-Maffei Wegmann (KMW) of Kassel, Germany and SP Aerospace and

Vehicle Systems B.V. of The Netherlands. The Fennek will be equipped with a sensor platform that includes a camera, a thermal imager, and a laser rangefinder (codeveloped by EADS and Rheinmetall Defence Electronics), and the HRM-7000 tactical radio (produced by EADS). Maritime ISR capabilities include three OSTE Class 423 ships that have been deployed since the late 1980s for SIGINT and electronic warfare missions.

Several projects are underway to acquire future ISR capabilities. The most significant is the plan to procure six HALE Global Hawk UAVs, outfitted with electronic intelligence collection and analysis suites developed in Germany. These may also be tasked with SIGINT missions now handled by manned aircraft. Known as Euro Hawk, the project has received the approval of the U.S. Air Force and the German Ministry of Defense, and trial flights have been conducted in California and Germany. The system is planned to be interoperable with other ISR capabilities of the German armed forces, as well as with NATO ones. Flights are expected to begin in the year 2005, with final deployment of the system sometime in the year 2008.³⁴ Euro Hawk UAVs will also be the German contribution to the NATO AGS program (see below).

German space observation capabilities are currently being developed under project SAR-Lupe (a satellite-based SAR), to be deployed by 2007. The Balkans campaigns and difficulties obtaining U.S. imagery data made the importance of independent earth observation capabilities clear to the German defense community. SAR-Lupe will consist of five Low Earth Orbit (LEO) satellites, the first to be launched in 2005, and a ground segment. Total cost of the project is approximately €300 million. A European consortium, led by OHB Systems of Germany, is undertaking the project. Once SAR-Lupe is operational, Germany plans to exchange the data it provides with data collected from the French Helios 2 and the Italian COSMO satellites.

Currently, intelligence collected from Germany's surveillance and reconnaissance assets is disseminated to warfighters using several different systems. One of these, in use by the German Army, is the LABB-BW (*Luftbild-Auswerteanlage der Bundeswehr*, or Aerial Picture Analysis Station for the Armed Forces) system, designed for the exploitation of intelligence (still images and film) collected by manned or unmanned aerial reconnaissance systems. It can be

³⁴ Martin Agüera, "Global Hawk Goes to Europe," *Defense News*, 23 June 2003.

deployed in both stationary and mobile (vehicle-mounted) stations. Originally designed for the CL-289 tactical UAV, it has been in operation since 1991. An extension program was launched in 1999 to upgrade the system to a common aerial image exploitation station. Currently, the LBAA-BW can work with imagery collected by CL-289 UAVs as well as by Tornado and Breguet Atlantic aircraft. More than 50 units have been deployed. In 2007, the GAST (*Gemeinsames Auswerte-System*, or Common Analysis System) project, begun in 2003, will create a common system for the dissemination of all intelligence collected via technical means through a single database.

Table 4. German C4ISR capabilities

	Deployed today	Deployed by 2005	Deployed after 2005	Interoperability
C2				
Heeres-Führungsinformationssystem für die rechnerunterstützte Operationsführung in Stäben (HEROS)	Corps-, division- and brigade level C2 system; includes mobile elements			Also deployed with EUROKORPS and the German-Dutch Corps
Führungsausstattung taktisch (FAUST)	Regiment-level and below C2 system; includes mobile, APC-based elements			
Mobile Command and Control System (MCCS)	C2 system for army's tanks and armored vehicles designated for overseas deployment			
Marine Headquarters (MHQ)/Maritime Command and Control Information System (MCCIS); Collaboration at Sea (C@S)	Tactical naval C2 systems (incl. links to HQs)			C@S enables interoperability with some U.S. ships
German Air Force Command and Control Information System (GAFCCIS)	Air force C2 system			
ADLER	Artillery corps C2 system			
HflaAFüSys	Air defense C2 system			
RUBIN	High-level C2 system			

	linking armed forces command with MOD			
Surface-Air Missile Operations Center (SAMOC)		Next generation, mobile air defense C2 system		Interoperable with NATO nations' air defense C2 systems; for use in multinational deployments
FüInfoSys H			Integration of HEROS and FAUST into single army C2 system; deployment expected in 2006	
Pilot Project 9.4.4			Integration of all C2 (navy, air force, army) C2 systems	
Communications and Computers				
Automatisiertes Korpsstammnetz (AUTOKO) 90	Army tactical communications digital infrastructure; in place since 2000; its limited bandwidth will require a series of upgrades in the near future			Cannot handle IP traffic; limited interoperability due to use of EUROCOM standard
Breitbandiges, integriertes Gefechtsstand-Fernmeldesystem (BIGSTAF)	Broadband command post communications network for brigade, divisional and corps command posts; integrated into Autoko-90			Limited interoperability due to use of EUROCOM standard
Tactical Mobile Radio Network	Navy communications system linking all			

	vessels			
AutoFü	Communications system linking all air force bases			
Link-11 / MIDS	Equipped on some navy vessels and Luftwaffe Tornados and NH-90 helicopters			Enables interoperability with other vessels and aircraft equipped with Link-11 / MIDS
ISDN-BW	Cross-service digital communications network linking all central commands			
Krisenreaktionskräfte–Interoperabilität (KINTOP)	Mobile communications system for expeditionary forces			Uses TETRAPOL standard and interoperable with other TETRAPOL-based systems
SATCOM-BW Phase 1	Leasing of commercial satellite capacity for linking expeditionary forces back to HQs			
SATCOM-BW Phase 2			2 new satellites; in orbit by 2008	
ISR				
CL-289	Tactical, corps- and division-level recon and target acquisition UAV; feature black-and-white cameras and IR sensor			
Breguet Atlantic 1150	Manned aircraft for maritime S&R and SIGINT/EW missions			
Fennek	ISR vehicle			Similar vehicles

				deployed by Royal Netherlands Army
OSTE	SIGINT and EW ships			
Luftbild-Auswerteanlage der Bundeswehr (LBAA-BW)	Common aerial image exploitation station for all German defense forces			Exploits images from CL-289, Navy Tornados, and Breguet Atlantic aircraft
Taifun			UCAV with target identification and engagement capabilities; initial deployment expected in 2009	
Micro Air Vehicle			Micro-UAV (30 cm wingspan, 1,000 km range) for the German Army; expected to be deployed in 2005	
Euro Hawk			HALE UAV system; will include intelligence collecting and processing capabilities; deployment expected in 2008	Interoperability with different ISR systems of the German armed forces, NATO and EU is planned, as well as with the U.S. Global Hawk system
SAR-Lupe			5 LEO satellites and a ground segment; operational in 2007	Germany will have access to Italy's COSMO and France's Helios 2 systems in exchange for SAR-Lupe
Gemeinsames Auswerte-System (GAST)			Common system for the dissemination of all intelligence collected via technical means	

Italy

Italy is moving at a relatively slow pace toward interservice interoperability and other advanced C4ISR systems. Much of the country's defense budget over the next few years will be spent on weapons platforms, most notably on 121 Eurofighter aircraft. Much-needed C4ISR assets, such as early warning aircraft and aircraft data links, may not be purchased in the near term.³⁵ Italian-U.S. industrial defense industry collaboration is seen as a way to advance the deployment of network centric capabilities and achieve interoperability with the United States. Italy is prepared to buy U.S. technologies as interim solutions to operational problems, as seen in the recent procurement of Predator UAVs and Link-16 systems, and in the interest shown in the U.S. Multimission Maritime Aircraft (MMA) project. Some Italian defense policymakers have argued that American C4ISR standards will lead the way and that Italy should work toward those standards.³⁶ For now, Italy intends to ensure that all communications systems and information databases are compliant with NATO STANAGs, while purchasing additional modules from the United States when these can solve specific interoperability needs, especially for the navy and air force.

Italy also seeks active participation in European R&D programs as a way to define common European requirements and standards at an early stage. This is also true for NATO programs, such as AGS and ACCS (see below). Italy has also begun deployment of UAV-based ISR capabilities. Having developed independent capabilities in SATCOM, Italy is also committed to greater intra-European cooperation in the development of future space assets.

Command and Control

Italy's services have each gone their own way in C2. Single service C2 systems are deployed by the Italian Air Force (SICCAM), Navy (LEONARDO), and Army (SIACCON—the *Systema Automatizzato di Comando e Controllo*, or Automated Command and Control

³⁵ Tom Kington, "Funding 121-Aircraft Purchase Slows Italy's Net-Centric Drive," *Defense News*, 3 May 2004, [page #].

³⁶ Interview in Washington, DC.

System). The latter provides automated support for military units at corps, division, brigade, and battalion level, and is compliant with NATO STANAGs.

While the air force and navy systems are still mostly independent, the Italian Army has fused its C2 systems and the air defense C2 system into a single network under the CATRIN program, delivered in July 2000. CATRIN is made up of three different functional subsystems. SORAO controls ground surveillance and provides battlefield awareness, target acquisition, and information from meteorological and NBC sensors. The SOATCC subsystem is responsible for air surveillance, and provides C2 over army air defense units and army aviation units. The third subsystem, SOTRIN, ensures the communication flow between the various command centers.

The most important future C2 system under development is the Command, Control, and Navigation System (*Sistemi di Comando, Controllo e Navigazione*–SICCONA), a C2 system that will link all the army's armored vehicles and provide them with access to the existing SIACCON system. Fifty units of the SICCONA system are expected to be deployed sometime in 2006-2007.

Communications and Computers

The majority of the communications systems deployed by the Italian armed forces were designed to meet NATO STANAGs. Some Link-16 systems, purchased from the United States, have been installed on Tornado F3 aircraft, and Italy is a partner in the MIDS consortium. Additionally, the Italian Navy is currently working on the implementation and testing of Link-11 on some vessels. However, the tactical digital communications infrastructure of the Italian armed forces is still in its early stages of deployment. An intranet backbone for the Ministry of Defense called DIFENET, based on fiber optic links, is currently under development. A military digital information network (*Rete Numerica Interforze* - RNI) is also under discussion.

Italy's terrestrial communications system is complemented by the SICRAL (*Sistema Italiano per Comunicazioni Riservate ed Allarmi*, or Italian System for Reserved Communications and Warning) MILSATCOM system. The first satellite, SICRAL 1a, was

launched in 2001, carrying the first operational EHF communications capacity produced in Europe. However, it does not include onboard processing and therefore cannot be fully interoperable with U.S. systems or compatible with recently approved NATO EHF STANAGs. However, SICRAL is interoperable with the British Skynet 4 and with most of the channels of the French Syracuse and the Spanish Hispasat systems. The system includes over 100 fixed and mobile terminals, including several to be deployed on Italian fighters. SICRAL 1b is scheduled to begin service in 2006. The next generation of satellites in this series, SICRAL 2, is scheduled for launch around 2010. The latter will replace SICRAL 1a and is expected to include onboard SHF processing and frequency-hopping capabilities.

Intelligence, Surveillance, and Reconnaissance

Italy's unmanned ISR capabilities are based largely on foreign technologies, although eight domestically developed Mirach-26 and Mirach-150 tactical UAVs were introduced to the Italian army in 2002. Italy recently acquired six Predator MALE UAVs, intended mainly for reconnaissance missions. Full deployment is expected in 2005. Twenty CL-289 tactical UAVs were purchased from EADS in 2002. Additionally, Italy possesses some manned ISR assets. These include eighteen Breguet Atlantique aircraft for maritime reconnaissance and one Alenia G-222VS aircraft for airborne SIGINT operations (the latter was used successfully in Kosovo, but is scheduled to be replaced by two new C-130J aircraft in 2005 or 2006). A battlefield surveillance system, called CRESO (*Complesso Radar Eliportato per la Sorveglianza*, or Combined Heliborne Surveillance Radar), is deployed for operational and tactical missions. The system, carried on board Agusta-Bell 412 helicopters, includes a MTI and FLIR. Four such systems are currently operational, all designed to meet NATO STANAGs and to link with other systems via MIDS and the Italian SICRAL COMSAT. Additionally, the Italian Air Force flies several Tornado fighter-bombers (ECR version), equipped with FLIR sensor and an infrared line scanner for reconnaissance missions.

Italy's space-based observation capabilities are currently in the R&D stage. Having participated in the French Helios 1 and Franco-German Horus satellite programs (the latter discontinued in 1998), Italy is seeking independent earth observation capabilities. Under the

COSMO-Skymed project (COnstellation of Satellites for Mediterranean basin Observation), Italy will deploy a constellation of four radar-imaging satellites. The radar satellites would feature a SAR sensor (SAR-2000) capable of less than one-meter resolution for the military, and of approximately one-meter resolution for images sold commercially. The COSMO-Skymed system is managed by the Italian Space Agency; Alenia Spazio is the prime contractor. The Italian Ministry of Defense has committed funds to the project in exchange for 20 percent of the satellites' viewing time. COSMO-Skymed is expected to be fully deployed and operational by 2007. Once all satellites are in place, the constellation will be able to take images of any location on the earth's surface with a revisit time of 12 hours.

According to an agreement signed between France and Italy in January 2001, COSMO-Skymed will be linked to the French Pleiades constellation via ORFEO, a program designed to ensure interoperability and information sharing. As part of this agreement, Italy will receive access to French Spot 5 and to Helios 2 imagery. Italy is also negotiating with Argentina regarding the possibility of integrating two Argentinean radar satellites into the COSMO-Skymed system.

Future maritime ISR capabilities were planned under the framework of the Italo-German maritime patrol aircraft program. This program, now canceled, would have provided Italy with 14 aircraft by the year 2010. It is currently unclear if Italy will continue with an independent program for the deployment of next-generation manned maritime ISR capabilities. There has been talk of Italy joining the U.S. MMA project, as well as of the leasing of American P-3 Orion aircraft by the Italian Navy and Air Force (which currently jointly operate the fleet of Atlantiques).

Table 5. Italian C4ISR capabilities

	Deployed today	Deployed by 2005	Deployed after 2005	Interoperability
C2				
Systema Automatizzato di Comando e Controllo (SIACCON)	Army C2 system			Meets NATO STANAGs
SICCAM	Air Force C2 system			
LEONARDO	Navy C2 system			
CATRIN	Army and air defense C2, communication and intelligence system			
SICCONA			Integration of all C2 systems, to be deployed by 2006/7	
Communications and Computers				
Link-11/16	Deployed on several aircraft and ships			Links to allied Link-11/16 systems
DIFENET		MOD intranet based on fiber optic links		
Satellite Italiano per Comunicazione Riservate (SICRAL 1)	MILSATCOM system			Partly (only SHF and UHF capabilities) meets NATO STANAGs; interoperable with Skynet 4 and with most of the channels of the Syracuse and Hispasat systems
SICRAL 2		Onboard SHF processing capability and frequency-hopping		Compatible with NATO and Skynet 4 but not with U.S.

		protocols		
Rete Numerica Interforze (RNI)			Military digital information network	
ISR				
Mirach-26/150	Tactical UAVs used by army			
Predator	MALE UAVs			Purchased from U.S.
CL-289	Tactical UAVs			
CRESO	Heliborne SAR system for operational and tactical R&S			Meets NATO STANAGs; links to allied systems via MIDS and SICRAL
Tornado ECR	FLIR sensor and IR scanner for recon missions			
Helios 1	French optical satellite program			Access to some of the imagery
Breguet Atlantique	Maritime S&R			
Alenia G-222	1 SIGINT aircraft			Used during the Kosovo crisis
C-130J		SIGINT aircraft		
COSMO Skymed			Constellation of four SAR satellites	Access to French Helios 2 and German SAR-Lupe imagery in exchange for COSMO imagery

The Netherlands

The Netherlands armed forces place a priority on interoperability with NATO. All new Dutch equipment is required to be interoperable with NATO STANAGs. The navy and air force are increasingly interoperable with each other and with other European services, while the army's tactical data links lag behind. With the completions of the ISIS and TITAAN projects, the air force and army will share the same C2 system and communications infrastructure. The Netherlands military lacks the resources to procure equipment across the spectrum of capabilities. They have focused instead on involvement in several major high-technology programs, such as the JSF and the Patriot anti-aircraft batteries, and on ensuring that deployed C4ISR assets are built to NATO STANAGs.

Defense budget cuts for 2003 and 2004, however, may not leave enough resources for all procurement and R&D programs needed for a complete transformation of the Netherlands armed forces. In these two budget years, the reduction in force element size targeted traditional platforms, including the Navy's frigates (which were reduced from 14 to 10) as well as in C4ISR assets such as maritime patrol aircraft (all of which are being sold).³⁷

The binational German-Netherlands Corps, created in 1985, became a NATO High Response Force between 2000 and 2002. It is under operational command of SACEUR, but can also carry out EU-led operations. Its C4ISR assets include the German HEROS C2 system, the Dutch TITAAN communications infrastructure (VoIP WAN with SATCOM and HF radio), and Sperwer tactical UAVs procured from France.

Following the NATO Prague summit, the Netherlands army also announced that it will build an Intelligence, Surveillance, Target Acquisition, and Reconnaissance (ISTAR) battalion that will be able to operate with other NATO allies.

³⁷ R. De Wijk, "The Implications of Force Transformation: The Small Country Perspective," in *Transatlantic Transformation: Equipping NATO for the 21st Century* (Washington, DC: Center for Transatlantic Relations, 2004), 124-125.

Command and Control

The Netherlands has invested significantly in advanced C2 systems. For the Royal Netherlands Army and Air Force, these include the ISIS (Integrated Staff Information System) for mobile headquarters and the army's Battlefield Management System (BMS) for lower command levels (battalion-level and below). The latest 3.0 version of ISIS became operational in early 2004. Investments have also been made in the systems for the navy (LCF frigates), artillery (VUIST) and armor (Target Information Command and Control–TICCS) to make each compliant with NATO STANAGs. It is not yet clear that a full integration of all C2 (navy, air force and army) systems is being planned.

Communications and Computers

The Dutch military's digital communications infrastructure is the Netherlands Armed Forces Integrated Network (NAFIN) supplied by Nortel Networks. Fully operational, NAFIN supersedes the previous leased PTT public line systems with a secure, high-speed network linking more than 250 military installations in the land, sea and air services.

The Dutch army deploys a mobile tactical digital communications system. Its backbone, the ZODIAC (ZOne DIgital Automated and enCrypted Communication) system supplied by Thales Netherlands, is based on the EUROCOM standard, making it interoperable with only a few NATO allies, notably Germany. The radios deployed are Single Channel Radio Access units by Thales Netherlands as well as HF-EZB systems. Additionally, the Royal Netherlands Air Force is currently in the process of procuring some 120 MIDS terminals for its F-16s, and a few of these aircraft are already equipped with this technology.

The new generation of military communications for the Royal Netherlands Armed Forces is the TITAAN (Theatre Independent Tactical Army and Air Force Network) that brings together legacy and new systems into a converged network. It provides the Netherlands Army and Air Force with voice (via IP telephony) and video, as well as network management and security. In 2002 the army began replacing the ZODIAC system with the first TITAAN modules. In 2004,

the air force will deploy the TITAAN system for mobile communications. TITAAN will eventually link to the navy's communication network.

In 2002, the Dutch MOD launched the first phase of its MILSATCOM program. The German company ND Satcom was awarded a contract to deliver a turnkey SATCOM network to the Dutch armed forces, consisting of one ground station with two C-band, one Ku-band and one X-band terminal (plans for a second X-band terminal are being drafted). To date, the project has allowed the Satellite Ground Segment at Lauwersmeer to interconnect with NAFIN, the communications backbone of the Netherlands Armed Forces. Two new AEHF terminals should be operational by 2009. The Dutch have also offered to fill part of NATO's future MILSATCOM needs through their system.

Intelligence, Surveillance, and Reconnaissance

Dutch unmanned ISR capabilities expanded considerably with the procurement of thirty-eight Sperwer UAVs from France. Deployed since mid-2000, they are chiefly used for tactical ISR and target acquisition missions. The Dutch would like such systems to perform more elaborate missions; to achieve this, they have initiated a collaboration with France for the development of the next generation of MALE UAVs, likely based on the Eagle UAV developed by EADS.³⁸

For ground-based ISR, the Royal Netherlands Army will begin deploying the Fennek vehicle in 2004. Produced by Krauss-Maffei Wegmann (KMW) of Kassel, Germany and SP Aerospace and Vehicle Systems B.V. of the Netherlands, the Fennek will be equipped with a sensor platform that includes a camera, a thermal imager and a laser rangefinder (codeveloped by EADS and Rheinmetall Defence Electronics), and HRM-7000 tactical radios (produced by EADS).

For maritime reconnaissance, the Netherlands Navy has relied on its fleet of thirteen Orion P-3C aircraft, ten of whose ground surveillance capabilities have recently been upgraded.

³⁸ Andrew Chuter, "French-Dutch UAV Draws Interest in Europe," *Defense News*, 13 October 2003, 4.

The upgraded planes, delivered in November 2003, possess new ESM, more advanced radar and acoustic sensors, and improved mission systems. The upgrades also make the P-3C aircraft more interoperable with those of the U.S. Navy. However, talks are currently underway with Germany to sell eight to ten of these aircraft to Germany and the remainder to Portugal, thereby eliminating a C4ISR element of the Dutch Navy.

Ground ISR capabilities include 62 recently acquired and deployed SQUIRE man-portable surveillance radars for the Royal Netherlands Army and Marine Corps. The radars provide MTI as well as bomb damage assessment capabilities.

Table 6. Dutch C4ISR capabilities

	Deployed today	Deployed by 2005	Deployed after 2005	Interoperability
C2				
Integrated Staff Information System (ISIS)	Army and air force mobile headquarters C2 system			Meets NATO STANAGs
Battlefield Management System (BMS)	Lower army command levels (battalion and below)			Meets NATO STANAGs
LCF frigates C2 systems	Navy C2 system			Meets NATO STANAGs
VUIST	Artillery C2 system			Meets NATO STANAGs
Target Information Command and Control (TICCS)	Armor C2 system			Meets NATO STANAGs
Communications and Computers				
Netherlands Armed Forces Integrated Network (NAFIN)	Digital communications infrastructure linking all three services			
ZODIAC	Army mobile tactical digital communications infrastructure			Interoperable with those NATO forces using the EUROCOM standard
TITAAN (Theatre Independent Tactical Army and Air Force Network)	Next generation, VoIP-based army and air force mobile digital network; will eventually replace ZODIAC and also be deployed by navy			COTS based
MILSATCOM program	1 ground station and			Connected to NAFIN

	four terminals; two AEHF terminals to be added by 2009			network
ISR				
Sperwer	Tactical UAVs used for S&R and target acquisition missions			
Orion P-3C aircraft	Maritime reconnaissance with recently upgraded radar, acoustic sensors, and mission systems			
Fennek	Reconnaissance vehicle with camera, a thermal imager and a laser rangefinder			Codeveloped with Germany
SQUIRE	Man-portable surveillance radars fielded by Royal Netherlands Army and Marine Corps			
Next generation MALE UAV			Possibly based on the Hunter or Eagle models	Codeveloped with France

Spain

Spain has been slow to integrate cross-service C2 and communications infrastructures in its armed forces. Army and air force C2 systems were fully deployed only recently. SATCOM fills much of the military's needs. There is a limited budget for ISR systems, and Spain relies heavily on locally developed products (mainly UAVs and SIGINT systems) for this capability. Few of the Spanish systems are interoperable.

Spain is one of the few Western European countries to have significantly increased its defense budget for 2004. The 4.5 percent increase will pay for a 15-year modernization program. However, much of the procurement plans are for big-ticket items, such as Eurofighter Typhoon, A400M airlifters, Leopard tanks and Pizzaro infantry fighting vehicles. Few large C4ISR military procurement or R&D programs are expected in the near future, and the budget for the Ministry for Science and Technology, which is also responsible for some high-technology defense R&D programs, is not clear.

Spain has some experience with coalition expeditionary operations through its membership in the Spanish-Italian Amphibious Force (SIAF). Created in 1997, SIAF is a binational amphibious force; its first exercise was carried out in 1998. It is activated on call by common agreement and it will be called on for Multinational Amphibious Task Force (under NATO command), European Marine Force (EUROMARFOR—under EU command) or national (Italian or Spanish) missions. SIAF command rotates every 12 or 24 months between the member nations.

Command and Control

Several C2 systems are currently operational in the services. In the Spanish army, the main C2 system is the Army Command and Control Information System (*Sistema de Información para Mando y Control del Ejército de Tierra—SIMACET*), which provides a common battlefield picture for all command centers. It covers all operational echelons, from army corps, division, brigade, battalion or independent units (e.g. expeditionary forces, groups of armored vehicles, etc.). For the air force, the Aerial Command and Control System (*Sistema de*

Mando y Control Aéreo–SIMCA) has been deployed since 2001, and is compliant with NATO standards. There is not yet a plan for the integration of the Spanish C2 system across the services.

Communications and Computers

The Spanish tactical digital communications infrastructure consists of PR4G tactical radios deployed through the ARGOS project. There is little funding, however, for further network integration of communications systems, except for the procurement of several MIDS systems for aircraft and ships.

Current MILSATCOM capabilities consist of the Hispasat civilian telecommunications satellites, which also carry military communications. Four Hispasat satellites are currently in orbit, the most recent launched in 2002; however, only the two oldest, launched in 1992 and 1993, carry military communications payloads. The Hispasat system is compatible with the France's Syracuse 2, Britain's Skynet 4 and the NATO 4 system.

MILSATCOM are under development in the Spainsat program, undertaken by Hisdesat and Loral. This satellite will operate in the X-band and possess an antijamming system. The Spanish Defense Ministry will lease approximately five of Spainsat's thirteen transponders; the rest are expected to be leased by the United States and other NATO allies. Planned launch is sometime in late 2004 or early 2005.

Intelligence, Surveillance, and Reconnaissance

For unmanned ISR, Spain relies on the locally manufactured SIVA (*Sistema Integrado de Vigilancia Aérea*, or Integrated System for Aerial Surveillance), a tactical UAV for reconnaissance, surveillance and target acquisition. Spain has also expressed an interest in Northrop Grumman's Fire Scout vertical take-off and landing tactical UAV for maritime S&R capabilities. Manned ISR assets include five Orion P-3B aircraft, upgraded in 2003 by EADS to include the FITS mission system, an electronic warfare system, new radar, acoustic system, ID

friend-or-foe interrogator, V/UHF and HF radios, a data link, and satellite and inertial navigation systems.

Space observation capabilities were planned for 2003 with the finalizing of the Ishtar optical earth observation satellite. However, the project did not go forward. Instead, Spain became a junior partner in the French Helios 2 satellite program.

Since March 1998, Spain has operated a single Boeing 707 (the Santiago), configured for SIGINT and ISR missions. Two Falcon-20 aircraft are also in operation for COMINT missions.

Table 7. Spanish C4ISR capabilities

	Deployed today	Deployed by 2005	Deployed after 2005	Interoperability
C2				
Sistema de Información para Mando y Control del Ejército de Tierra (SIMACET)	Common battlefield picture for all army command centers (incl. Mobile and expeditionary)			
Sistema de Mando y Control Aéreo (SIMCA)	Air force C2 system			Complies with NATO STANAGs
Communications and Computers				
ARGOS	PR4G radio-based tactical digital communications infrastructure			
MIDS		Installed on several aircraft and navy ships		Links to other MIDS systems in allied nations
Hispasat	Commercial SATCOMs from early '90s with some transponders leased to Spanish military			Partly interoperable with the Syracuse (France), Skynet (UK) and NATO 4 systems
Spainsat		MILSATCOM - UHF and SHF capability along with some EHF capacity and an antijamming system; planned launch is sometime in 2004		
ISR				

Sistema Integrado de Vigilancia Aérea (SIVA)	Tactical UAV for reconnaissance, surveillance, and target acquisition			
Orion P-3B	Upgraded in 2003 to include FITS mission system, an electronic warfare system, new radar, acoustic system, IFF, V/UHF and HF radios, data link, and satellite and inertial navigation systems			
Santiago	Boeing 707-351C configured for COMINT/ELINT and OPINT operations			
Falcon-20	2 aircraft for COMINT missions			
Helios 2			Next-generation French earth observation satellite; IR and optical IMINT capabilities	Access to imagery from Pleiades system

Sweden

The Swedish Armed Forces, urged by the Swedish parliament, have created an ambitious, long-term vision for the creation of a Network Based Defense (NBD). According to the NBD philosophy, information technology will be used to create a system of systems infrastructure, and enable different platforms to link into it. This process will take twenty to thirty years; however, the first steps are already underway, including the developing and purchasing of advanced C2 and communications capabilities for aircraft, ships and land vehicles and the initial design of a Network Based Defense architecture. A major demonstration is expected in 2005. The Swedish Defense Research Agency (FOI) plays a key role in establishing this vision.³⁹

The Swedish Armed Forces today, however, remain only partially interoperable across the services. An infrastructure is currently being put in place to unify all existing C2 systems, since all the services are now under a single national command. This command has begun the transformation of the Swedish military into a contingency organization based on a mobile, high-quality force, able to operate in an expeditionary mode. Many of the systems used by the Swedish military are compliant with NATO STANAGs and U.S. MILSPECS, giving them a good basis for achieving interoperability.

Sweden has its own rapid reaction units: the army's SWERAP, the air force's SWAFRAP and the navy's SWENRAP. Four C-130 air force C-130s provide air insertion capability. JAS-39 Gripen aircraft participate in air missions that include S&R; the navy's missions are mainly mine clearing, and land forces are mainly used for peacekeeping. SWERAP uses the KV90 communications system (HF radios with satellite link to national headquarters).

Command and Control

Current C2 systems in the Swedish armed forces include the 9LV system (in service with the navy) and the StriC-90 system deployed since 1998 for the C2 of attack aircraft and air defense systems. StriC-90 uses the Giraffe 3D and the Erieye radars, and includes data links with

³⁹ *Military Technology*, "The Implementation of Swedish Network Based Defense," XXVI (2002): 26-27.

Gripen attack aircraft. Other C2 systems are operational with the Swedish armored corps and army, including a mobile headquarters wireless LAN experiment and the IS-Mark system for non-mobile headquarters C2. Integration of all C2 (navy, air force, army) systems (at all levels) is planned for 2005.

In October 1995, the Swedish Defense Research Establishment (FOA), the Defense Materiel Administration (FMV), and the National Defense College (FHS) were tasked by the Department of Operations, Swedish Armed Forces Headquarters, to propose a vision for a mobile military joint C2 system for the year 2010. This project - ROLF 2010 - has been expanded to include civilian C2 elements relevant to national security. The goal is to create a 10-15 year vision for the C2 environment of Sweden's national defense and rescue services. The vision calls for the creations of an aquarium, a device for the presentation of crisis situations in a 3D environment, fusing information collected from various sources. Dubbed Visionarium, the system is now being developed under a separate project. Once deployed, it will enable informed and timely decisionmaking and the dissemination of decisions to security forces.

Communications and Computers

The tactical communications infrastructure of the Swedish Armed Forces has recently been upgraded to a digital network, the TS-9000. However, it has encountered problems of data capacity, requiring continuous upgrades. The system is based on Thales switches and Ericsson radios and relay equipment.

The requirement for a more powerful communications infrastructure will be filled through the procurement of the HF-2000 radio communications network, which is to be fully deployed by 2008. This system will provide all of the military with a fully automated data, text and voice communications network that can be used from fixed and mobile stations.

The Rapid Reaction Unit fields the KV-90 communication system, to be fully deployed by 2008, with a digital backbone by Alcatel, radios by Ericsson, and routers by Cisco. It provides both military communications services for the soldiers and connections home.

Intelligence, Surveillance, and Reconnaissance

Sweden's manned airborne ISR capabilities are the ARGUS system. Based on Saab's 340 Airborne Early Warning (AEW) aircraft and outfitted with Ericsson's Erieye PS 890 radar, the platform performs mostly aerial and maritime surveillance and reconnaissance missions. First introduced into the Swedish Air Force in 1997, six aircraft and four radar stations were delivered by the year 2002.⁴⁰ Other manned ISR assets include two Gulfstream IV-SP aircraft, deployed since 1997 for SIGINT missions. Additionally, the Giraffe radar by Ericsson, whose deployment was begun recently, provides land-based ISR capabilities. Its main mission, however, is air defense. A maritime version, the Sea Giraffe, is also deployed.

Sweden currently has relatively little unmanned aerial ISR capability. Three Ugglan (Owl) tactical UAVs were procured from SAGEM in 1999-2000; these are Sperwer UAVs slightly modified to suit the needs of the Swedish army. However, as part of the Swedish Armed Forces' long-term vision, a number of advanced UAV concepts are currently being studied. One is Gladen, a HALE UAV equipped with a SAR, electro-optic and infrared sensors, and able to carry an early warning suite. Also under discussion are two combat UAVs: the Swedish Highly Advanced Research Configuration (SHARC), an attack UAV, and Skuadern, a stealthy MALE reconnaissance and strike UAV (both under development by Saab, the latter in collaboration with BAE Systems). Sweden is also collaborating with France, Spain, and the Netherlands on a common MALE UAV project.

⁴⁰ *Military Technology*, "Airborne Surveillance Radar FSR 890/EriEye," XXVI (2002): 31.

Table 8. Swedish C4ISR capabilities

	Deployed Today	Deployed by 2005	Deployed after 2005	Interoperability
C2				
StriC	Air defense C2 system			Interoperable with the Swedish Argus airborne radar system
9LV Mark 3E	Naval C2 system			
IS-Mark	Army C2 system (incl. mobile and nonmobile headquarters)			
9LV CETRIS			Naval C2 system for next-generation Visby-class corvettes	
Integrated C2 system		Planned to connect all services by 2005		Interoperability issues may be sacrificed to keep to a schedule
Communications and Computers				
TS9000	Army tactical communications infrastructure			
KV90	Communications system for Swedish Rapid Reaction Force			
HF2000			Future radio communications network (data and voice) for all services (fully deployed by 2008)	Meets NATO STANAGs
ISR				
Ugglan	Tactical UAV (Sagem's			Also deployed by France,

	Sperwer)			Denmark, Netherlands, Greece
FSR-890 Argus	SAAB-340 aircraft modified for AGS and aerial C2 missions			Fully integrated into Swedish air defense system
Giraffe / Sea Giraffe	Land-based and maritime S&R radars			
S-102B Korpen (Raven)	2 Gulfstream IV-SP aircraft for SIGINT			Have been deployed in the Adriatic in support of NATO peacekeeping operations

C4ISR and NATO

Introduction

NATO provides the most current and complete setting for addressing transatlantic C4ISR technology and interoperability issues.⁴¹ Although the EU may evolve into an important future context for coordinating European policy, requirements, and acquisitions in the C4ISR arena, its military planning work is far too preliminary to provide a context for resolving interoperability problems today. In addition, the United States plays no part in the internal military and security policy structure of the EU, making a separate context for dealing with the transatlantic relationship necessary. Almost inevitably, more than fifty years of history and experience make NATO the default setting for this interaction.

In the Cold War, NATO force planning provided the critical setting for defining allied relationships on C2, communications, air defense, air operations, and air-to-air surveillance. Although our examination of national C4ISR capabilities indicates that national systems are imperfectly interoperable at the national level and not always interoperable within the alliance, the intent to make them interoperable for the alliance is clear.

Moreover, a number of capabilities were developed in NATO that remain important tools for alliance interoperability, even when used in coalitions of the willing formed outside the alliance itself. NATO maintains dedicated common C2 and communications capabilities, the MIDS upgrade of the U.S. Link 16 system connecting allied aircraft was developed through NATO, and NATO's naval communications are largely interoperable. The AWACS air-to-air surveillance system is a common NATO capability. NATO's role in defining and issuing STANAGs for many weapons systems, including C3I, have set targets for planning national C2 and communications systems among the member nations for years.

⁴¹ Frans Picavet, *Consultation, Command and Control Support in NATO*, Presentation to AFCEA (February 13, 2003), slide 34. For the purposes of this discussion, we will use the definition of interoperability common in NATO, as described by Maj. Gen. Picavet, Director of the NATO HQ C3 Staff: "the ability of alliance forces, and when appropriate, forces of partner and other nations, to train, exercise and operate effectively together in the execution of assigned missions and tasks."

Moreover, NATO remains an important setting for a wide range of activities providing the next generation of C4 interoperability. Several common NATO projects bear directly on C4ISR requirements: the ACCS program, the AGS program, theater missile defense (TMD) research, and the Coalition Aerial Surveillance and Reconnaissance (CAESAR) ACTD program.

NATO may also become a driving force in future transformations of European military forces and their links to U.S. defense transformation efforts, thanks to three key decisions made at the November 2002 Prague Summit: the PCC, the NRF, and the creation of the new ACT.

However, NATO today is an uncertain context for the future, given the commitment of the Europeans to strengthening capabilities inside the EU and given ambiguity about the degree of U.S. commitment to coalition operations in general and to planning and executing those operations in the NATO context in particular.⁴² Thus, the future role of NATO in stimulating interoperability and defense transformation remains somewhat unpredictable.

NATO Role and Capabilities

Strategy, Force Planning, and Current Capabilities

During the Cold War, NATO was the principal institution through which the allies developed common C2 capabilities. These grew out of NATO strategy, force planning, and exercises, which historically set the overall expectations and goals for the military forces maintained by the member countries. Through the Alliance's force planning, members set goals for their own national investment in forces, which, in turn, influenced the requirements for equipment, including Command, Control, Communications, and Computers (C4). These are the military forces today that have to be linked together at the national level and across the alliance in alliance or coalition operations.

⁴² See National Security Strategy and Quadrennial Review, which seem to give preference to ad hoc coalitions, as opposed to systematic use of NATO.

NATO's history, however, may not provide an adequate incentive for defining and meeting C4ISR requirements today. While members signed up to meet certain goals, the NATO force planning goals are not obligatory and have often not been met in national defense budgets and plans. Because the goals have been developed through a negotiation, changes stimulated in the NATO context tend to be incremental, which no longer tracks with the speed with which change is taking place in the missions NATO forces are being given or in the evolution of defense technology.⁴³

Combined Joint Task Forces, Command, Control, and Communications

Over the years, NATO has taken its own approach to C4ISR, breaking the concept up into three categories: Command, Control, and Consultation (C3), Communications and Information Systems (CIS), and ISR. As will be described below, separate agencies were created to govern the first two areas (C3 and CIS) while the field of ISR was further broken down into specific programs and agencies to handle them. It is noteworthy that the NATO concept of C3 covers planning and architecture design of systems, while that of CIS covers the management and operation of systems.

In C3, the Alliance has, over the years, developed specific headquarters packages—Combined Joint Task Forces (CJTF) headquarters—which play a central role in planning and implementing particular operations involving the forces of two or more countries, such as IFOR and SFOR in the Balkans. Since the mid-1990s, CJTF core staffs have been established on a permanent basis within selected parent headquarters of the NATO military command structure. When the need arises for a CJTF to be deployed, the core staff is assembled and augmented as necessary, and forms a CJTF headquarters specifically structured to meet the requirements of the operation in question. These CJTF headquarters receive C2 and communications capabilities

⁴³ David C. Gompert and Uwe Nerlich, *Shoulder to Shoulder: The Road to U.S.-European Military Cooperability; A German-American Analysis* (Santa Monica, CA: RAND, 2002), 10. Gompert and Nerlich note that the NATO force planning process “has become sclerotic and increasingly disconnected from the U.S. national force transformation process since the end of the Cold War.” They note (64) the problem of relying on NATO force planning for transformation: “Adjustments in NATO’s military plans are worked out through tedious diplomatic negotiations among professionals trained to avoid abrupt change. Consequently, the United States and the lead European allies do not presently rely on the NATO planning process to guide their force planning, and they cannot count on it to organize and guide their effort to create cooperable transformed forces.”

provided both by the Alliance and by national forces. Such CJTF headquarters will also provide the emerging NRF (see below) with the joint headquarters it will require to operate.

The alliance has also developed a substantial dedicated C2 and communications capability for military operations, involving senior levels of military and political decisionmaking.⁴⁴ NATO hardware and software can reach across the entire NATO territory, connecting land, air, and maritime forces and political decisionmakers in national capitals and Brussels, including voice, data, messaging, and video teleconferencing. It uses wireless networks, satellites, land lines, optical fiber, and digital radio, and includes local area and wide area networks. A significant volume of this traffic is carried on the Internet and commercial equipment, including satellites.

These C3 and CIS infrastructures are overseen by the NATO Consultation, Command, and Control Organization (NC3O). The NC3O's mission is to develop the technical architectures, standards, protocols, and overall design for all systems, from the military tactical level to the political strategic one. Since its reorganization in 1996, the NC3O is managed by three different entities. The NATO C3 Board (NC3B) is the senior CIS planning and policymaking body in the Alliance and consists of representatives of all member nations, the strategic military commands, and other relevant NATO agencies; it reports directly to the North Atlantic Council (NAC) and the Defense Planning Committee, and acts as the oversight board for all NC3O activities.⁴⁵ The NATO Command, Control, and Consultation Agency (NC3A) is the agency directly responsible for systems. It carries out the policies of the Board, procures CIS systems, and conducts field trials of prototypes. NC3A's goal is to create an architecture for a common operating environment, into which member states can plug in their own C3 networks.⁴⁶ Lastly, the operator of the NATO systems is the NATO Communications and Information Systems Operating and Support Agency (NACOSA). It manages CIS, conducts joint training, and monitors the quality of service both in static and forward deployed locations. Over time, the

⁴⁴ For a very useful overview of these capabilities, on which this summary draws, see Charles L. Barry, "Transforming NATO Command and Control for Future Missions," *Defense Horizons* 28 (Washington, DC: Center for Technology and National Security Policy, June 2003).

⁴⁵ The Board has subcommittees on joint requirements and concepts, frequency management, information systems, identification systems, interoperability, information security, communication networks, and navigation systems. Picavet briefing, slide 17.

⁴⁶ Interviews in Brussels.

Board and the NC3A are pushing NATO into a command and information system toward greater mobility and interoperability, and the use of commercial products and systems. The goal is to create a ready-made architecture that member nations can plug into, and to provide a test bed for communications and Internet technologies.⁴⁷

The current NATO C2 system and its related communications capabilities have had their limitations, which the Alliance has worked to overcome. The system has not been mobile, though deployability is going to be key to future out-of-area operations. Moreover, the current capability is stove-piped; horizontal communications between forces and between governments are not systematically built in. The current system is a far cry from a network centric capability, allowing all sources of data, voice, and video plus sensor data to be brought together vertically and horizontally in real time to provide a coherent, real-time awareness of the battlefield.

NATO has, however, been upgrading its C2 and communication systems to become more network centric. Currently, a number of significant programs are underway, linked into transformational concepts of operation and enabling better handling of the new missions the alliance is undertaking.

- The Allied Command Europe (ACE) Automated Command and Control Information System (ACCIS), a strategic-level system providing decision support software and a combined operational picture, will be given a common hardware and software baseline that will form the core of a future bi-Strategic Command (ACE and ACLANT) automated information system (Bi-SC AIS);
- The core services of the Maritime Command and Control Information System (MCCIS), an Allied Command Atlantic (ACLANT) strategic-level, COTS-based information system, will be implemented in the ACE ACCIS architecture;

⁴⁷ See Charles L. Barry, "Coordinating with NATO," in *Transforming America's Military*, ed. Hans Binnendijk (Washington, DC: Center for Technology and National Security, 2002), 253.

- The NATO General Purpose Communications System (NGCS), a communications backbone tying all military C2 (data and voice) together, with semi-permanent bandwidth on demand, using secure and non-secure telephone, message, wireless, and satellite links, is being deployed to replace the obsolete NATO Integrated Communications System;
- The NATO Messaging System (NMS) will provide the Alliance commands with e-mail and secure military message handing capability;
- The NATO C3 Technical Architecture (NC3TA) is a new open systems approach for the Alliance's C2 infrastructure. It was initiated in December 2000, and has since then attempted to address near-term interoperability requirements of NATO C2 systems by setting down technical requirements and guidelines for their implementation.
- The SATCOM Post 2000 project (see below) will provide global wideband video, voice, and data links;
- The equipping of more NATO platforms with the Joint Tactical Information Distribution System (JTIDS) and the Multifunctional Information Distribution System (MIDS), a newer version of JTIDS (see below);
- Crisis Response Operations in NATO Open Systems (CRONOS), a Windows NT-based information system initially developed for Bosnia, currently provides secure connectivity (up to NATO Secret) between NATO and several national and coalition systems.⁴⁸

In sum, there is substantial NATO investment in creating the elements of a common C2 and communications architecture for the Alliance. What is lacking is a clear vision of what the Alliance needs to link sensor and other information into the decisionmaking and command

⁴⁸ Barry, p.7.

structures and the tactical war fighter. N3CA is working on such a vision, trying to define the linkage between the many NATO systems and standards, the incorporation of common programs such as MCCIS, ACCIS, ACCS and AGS into a joint system, and the integration of that system with the national systems of the member states. This C2 and communications architecture needs to be accompanied by a NATO-wide vision of the sensor architecture to which it needs to be linked. There are no clear NATO standards for the ISR elements of network centric operations, nor, as yet, an agreed view on the way in which they should be networked with each other.⁴⁹ Some current common NATO initiatives point in this direction, however, as discussed below.

Multifunctional Information Distribution System

The Multifunctional Information Distribution System (MIDS) is a useful illustration of the development of greater alliance interoperability in the C2 and communications arena. MIDS was designed to develop a tactical data communications network and the terminals for this network linking NATO allies' aircraft (fighters and bombers) and air-based, ground-based, and ship-based C2 centers.⁵⁰ As it is deployed across the alliance, MIDS will also enable better aircraft Identification Friend or Foe (IFF) information. The United States, France, Germany, Italy, and Spain signed the project memorandum of understanding in 1991. MIDS development has been led by the United States, with France acting as deputy program leader (reflecting the cost shares of the two major program partners).

On the technology side, MIDS, like the U.S. JTIDS, is based on Link-16, enabling a tactical digital network of encrypted, jam-resistant data links and terminals. Budget pressures and the desire to gain access to U.S. military technology led the Europeans to favor an international program, but almost all of them were unwilling to simply buy JTIDS off the shelf. For the United States, the need for international collaboration was operational: a common tactical communications network would lead to increased interoperability with European allies, meaning less dependence on U.S. fighters and increased effectiveness in coalition warfare.

⁴⁹ Interviews in Brussels.

⁵⁰ For a more comprehensive history of the MIDS program, see Hura et. al., op. cit.

Interoperability would be ensured because participating member nations would acquire MIDS terminals for their forces.

A modular open terminal architecture was developed, followed by an affordable terminal that could be readily tailored to fit various military platforms. At first, MIDS terminals were developed for integration into a specific set of platforms. Later, the architecture was modified to accommodate additional platforms. Finally, interoperable, jam-resistant data links between U.S. and allied platforms were developed. The member nations participating in the program were forbidden to develop competing systems to MIDS.

MIDSCO was awarded the R&D phase of the program. A U.S. chartered, international joint venture, MIDSCO included participation from GEC-Marconi Hazeltine (United States), Thomson (France), Marconi Italtel Defense (Italy), Siemens (Germany), and ENOSA (Spain). The contract for beginning work on MIDS was awarded in 1994, and the R&D phase was concluded in 2000.⁵¹

Airborne Warning and Control System

NATO also possesses an 18-aircraft fleet with dedicated, common, air-to-air surveillance capability, which provides an important sensor input to understanding the battlefield. Purchased during the late 1980s, this NATO E-3A fleet is currently being improved through modernization programs managed by the NATO Airborne Early Warning and Control (AEW&C) Programme Management Organisation. Together with the seven British E-3D aircraft and similar French and U.S. E-3 aircraft, Alliance air-to-air surveillance is significantly interoperable.

Standardization Agreements

In addition to its standing and planned set of C2 and communications programs and the AWACS fleet, NATO has worked for decades to set common standards for defense equipment,

⁵¹ The current acquisition strategy includes two U.S. vendors and one European vendor for production and sale of the terminals. The U.S. vendors are Data Link Solutions and ViaSat Inc. The European vendor is EuroMIDS, a consortium comprised of four companies - one from each of the European MIDS participating nations - Thales (France), Marconi Mobile (Italy), Indra (Spain), and EADS (Germany).

including C4. Through working groups in the NATO Military Agency for Standardization, in conjunction with NATO's Committee of National Armaments Directors (CNAD), members have negotiated more than 1,700 such STANAGs, which set out the standards members should seek to reach when acquiring new equipment. Roughly 300 of these standards relate to C4 technology.⁵²

The NC3TA proposes such standards for C2 and communications equipment, and information architecture. Their guidance should allow nationally-procured systems to link up with or plug into the C2 and communications architecture being put together by the Alliance.⁵³ As noted in the review of national programs in this study, many C4 items in national inventories have been defined to be compliant with NATO STANAGs, which, in theory, enhances interoperability.

The STANAG process has not, however, been fully successful in reaching this goal. STANAG compliance is not mandatory, but voluntary, and there is no institutional process in NATO for validating member-state use of the STANAGs. Many NATO member nations decide to go their own way with standards (see the German land force communications protocol, for example), limiting interoperability, even within their own forces. The United States is not an exception to this pattern.⁵⁴

Non-compliance with STANAGs is linked to the speed and technologies involved in achieving a network centric capability. The STANAG process tends to be long, tedious, bureaucratic and lowest common denominator. It does not have high-level attention and is not especially viewed as a part of the strategic evolution of the alliance, which can leave STANAGs well behind the evolution of modern technology.⁵⁵ This evolution is particularly fast, and

⁵² European Institute report, 37

⁵³ Barry, "Transforming NATO Command and Control for Future Missions," 10.

⁵⁴ See the conclusion of a transatlantic working group: "Most European countries, including France, are willing to use NATO standards, but it is not a usual practice in U.S. procurement for military services to refer (and defer) to them." *Transatlantic Interoperability in Defense Industries: How the U.S. and Europe Could Better Cooperate in Coalition Military Operations*, ed Jacqueline Grapin (Washington, DC: The European Institute, 2002), 3. Also see Robert Bell, NATO Assistant Secretary General for Investment, 63: "[I]mplementation has never been mandatory, and nations have in general even resisted monitoring, at the NATO level, national implementation."

⁵⁵ Grapin (ed.), *Transatlantic Interoperability*, 77. Rear Adm. Jan H. Eriksen, Director of the NATO Standardization Agency, noted in 2002 that NATO "has never defined how much or how deeply to standardize...Also NATO standardization has seldom drawn the interest of politicians or senior military officials."

commercially-based, in the case of C2 and CIS. As some countries move down the road of NCW, there is an understandable inclination to set STANAGs aside and move to the best available and most up-to-date technology. As a result, the transforming U.S. military is not significantly more successful than that of other NATO members in conforming to STANAGs.⁵⁶ Moreover, in the critical network centric area of ISR, there are only limited STANAGs and none, as yet for UAVs.⁵⁷

Future Common NATO Programs

Despite the shortcomings of the STANAG process, the Alliance has devoted increasing attention to C4ISR programs. Following the precedent of the upgrades to NATO's C2 and common communications systems, the Alliance has several current R&T programs that could lead to important, common C4ISR-related capabilities, providing greater future interoperability. Key among these are the ACCS, AGS, TMD, and CAESAR programs.

Air Command and Control System

Air defense could become a central element in a NATO move toward a more network centric focus. For years, the Alliance has commonly funded an air defense infrastructure, aimed at defending the NATO territory, including the AWACS fleet (see above). More than a decade ago, plans were begun to upgrade and expand this system through the NATO ACCS, also a commonly funded program. In 1990, the NATO ACCS Management Organization (NACMO) was established to conduct the planning and management of the ACCS program. Two of the principal features of ACCS are its open architecture and the emphasis placed on off-the-shelf components. Both are intended to permit evolution of the system without the need for major developmental effort.

Bell, notes, at 63: "STANAGs can take many years to draft and agree, and by the time they are eventually promulgated, the technology has moved on."

⁵⁶ The European Institute study group estimated that U.S. defense technology is 80 percent compliant with NATO STANAGs, but the remaining 20 percent is critical to the development of network centric capabilities. Grapin (ed.), p.3.

⁵⁷ Interviews and Erickson in Grapin (ed.), *Transatlantic Interoperability*, 77.

Given the declining air threat in the European theater, it seemed possible that the ACCS program would end. However, ACCS was designed not only for air defense (to detect and defend against air attack), but also for air tasking (to carry out the tactical planning, tasking and execution of all air defense, offensive air, and air support operations). It is intended as a multimission simultaneous planning capability, coordinating flight paths of various aircraft, integrating the AWACS air picture, preparing offensive operations, and coordinating a combined air operations center, along with reconnaissance squadrons and fighter wings. It will include both fixed sites and deployable components.⁵⁸

Operations over Kosovo revealed shortfalls in the Alliance's capability to coordinate combined air attack and support, giving new impetus to the need for this broad ACCS capability. Moreover, it became clear that ACCS could provide a vehicle for communications and C2 involving air operations as part of a network centric system, linked to air-ground surveillance and conceivably, even TMD.⁵⁹ After difficult discussions on industrial shares, the first ACCS contract for ACCS implementation was signed in 1999. The contract, worth some U.S. \$500 million, was initially signed with Air Command Systems International, part of the Thales Raytheon Systems joint venture.

Over a 69-month implementation schedule, TRS will develop and test the ACCS system core software, concluding the first phase of the program. This first stage could lead to an integrated air operations segment of a network centric capability for NATO. It might also be available as the platform for battle management of a NATO TMD system. However, the long-term commitment of funds to ACCS by the members of the Alliance is not certain.

Alliance Ground Surveillance

The NATO AGS project has been an active R&D program for over a decade, but has gathered serious momentum in the late 1990s.⁶⁰ The AGS program will provide NATO with an aerial battlefield surveillance capability using a radar suite with both MTI and SAR modes,

⁵⁸ Interviews in Brussels.

⁵⁹ Interviews in Brussels.

⁶⁰ *Defense News*, "NATO Surveillance Project Gathers Momentum", June 23, 2003, [page #].

fusing information gathered by other sensors into a combined digital picture. The United States currently fields such a capability in the JSTARS (a modified Boeing 707 carrying a communications, surveillance, reconnaissance, and intelligence suite).

After years of Alliance discussions and rejected proposals--including a U.S. proposal that the Alliance simply buy JSTARS, a United Kingdom decision to proceed independently with ASTOR, and the emergence of competing U.S. and European AGS proposals Multi-Platform Radar Technology Insertion Program (MP-RTIP) and Standoff Surveillance Target Acquisition Radar (SOSTAR)⁶¹--two transatlantic strategic alliances responded to the 2003 Request For Proposals for a two-year design and development phase, currently scheduled to begin by the end of 2004.⁶² Both offered the same radar solution--the Transatlantic Cooperative AGS Radar (TCAR)--based on a fusion of MP-RTIP and SOSTAR. One alliance was the Transatlantic Industry Proposed Solution (TIPS), proposed by a consortium led by Northrop Grumman, Thales, EADS, and Galileo Avionica, General Dynamics Canada, Indra, and some 70 other companies from all 19 NATO member nations. The other was the Cooperative Transatlantic AGS System (CTAS), proposed by Raytheon and British Aerospace Systems, based on the United Kingdom ASTOR system. In the spring of 2004, the NATO AGS Steering Committee and the NATO Conference of National Armaments Directors decided to move forward toward the signing of a contract, by spring 2005, selecting the TIPS consortium as the winning bidder.

Initially, the AGS system was to be deployed on manned aircraft. However, in response to German advocacy of UAV platforms, the program was redesigned for both manned and unmanned aircraft. It is not yet clear which version will be deployed first. The TIPS-based mixed fleet would be based on manned, medium-size aircraft (the Airbus A321) and HALE UAVs (the German Euro Hawk, a version of Northrop Grumman's Global Hawk).⁶³

⁶¹ MP-RTIP is an upgrade of the system deployed on JSTARS. SOSTAR is a planned European Standoff Surveillance Target Acquisition Radar.

⁶² *Defense Daily*, "NATO Members Endorse TIPS Proposal for Cooperative AGS Radar," December 5, 2002. The full program could include the deployment of six aircraft, as well as unmanned vehicles by 2010. Full program cost could be roughly \$3 billion.

⁶³ The CTAS solution would have been based on a fleet of business jets (the Bombardier Global Express).

For both consortia, the radar had posed a problem, since U.S. export regulators had indicated that they would forbid the transfer of the necessary technology needed to produce the Transmit/Receive (T/R) modules, a crucial element. The European partners, frustrated by this problem, have spent time and resources to duplicate existing U.S. T/R modules, creating a capability that, downstream, will compete with American technology.

The ultimate fate of the AGS system is still unclear, given the significant additional costs required for full deployment and longer-term uncertainty that some key NATO members—France, the United Kingdom and Germany—will continue to participate.⁶⁴ A commitment to deploy AGS involves a considerable increase in common NATO investments and would require an increase in the NATO common budget ceiling. This spending could compete with other national defense priorities. On the other hand, a deployed AGS would give the Alliance a significantly enhanced sensing capability for operational deployments outside the NATO area and relieve the overload on the U.S. JSTAR, currently much in demand.

Theater Missile Defense

Although not typically discussed under the C4ISR label, NATO has also undertaken an exploration of TMD programs for the Alliance. Two contracts have been let for studies of an Alliance TMD architecture, and the Alliance has formed a consensus that such a system should be deployed, though the first milestone is yet to be passed. The subject is relevant to the consideration of C4ISR for two reasons. Missile defense could be closely linked to the air defense and air operations capability provided by the ACCS program. Moreover, a TMD architecture could include mobile tactical missile and air defense capabilities, which Alliance forces may require in deployments overseas, including those of the NRF. The future of the NATO TMD studies is less clear than that of the ACCS and AGS programs, but it remains a potential context for C4ISR collaboration across the Atlantic.

⁶⁴ Interviews in Brussels suggest the 2004-06 next phase could cost \$350m.

Aerial Surveillance and Reconnaissance

NATO is also conducting a research and testing program with direct promise for the possibility of integrating sensor data into a C4ISR grid. CAESAR is an ACTD, funded by the Defense Department but, in a new precedent, operated by NATO. The premise of CAESAR is that the NATO interoperability challenge is about information—what is needed, who needs it, and where it comes from. The objective of CAESAR is to test national and NATO sensor systems, air- and space-based, and develop ways to integrate them, leading to a new STANAG for the Alliance.

The CAESAR program is testing tactics, techniques, and procedures for linking together independent national air reconnaissance and surveillance systems currently deployed on a variety of platforms, including the British ASTOR, the French Horizon, JSTARS, Global Hawk, RADARSAT (Canada), Predator, CRESO (Italian helicopter-based), and others. It could be extended to other platforms, including the British CEC network and, ultimately, ACCS and AGS (see above), and is being run by the same group at NATO doing the AGS planning.

The data emerging from the CAESAR tests, if it leads to investments and operational planning, could make a valuable contribution to NATO's effort to network sensor data into its C2 and Communications systems. It could also make it easier for coalition forces to rely on a variety of national air ground surveillance sensors, in the absence of a common NATO AGS asset.⁶⁵

In addition, CAESAR may provide a demonstration of the benefits that can be gained from funding ACTDs at the NATO and international level. ACTDs, a DOD acquisition reform designed to move technology more quickly into the forces, have normally been restricted to U.S. participants. More NATO-based ACTDs in the C4ISR arena could stimulate transatlantic efforts to solve the C4ISR interoperability problem.⁶⁶

⁶⁵ Interviews. Also see Robert Bell in European Institute, p.66.

⁶⁶ See European Institute, p.50, where the study group urges more NATO-level ACTDs.

Satellite Communications

SATCOM has already been an important element of NATO's common communications capabilities. The NATO 4 satellite system currently consists of one active COMSAT, one backup satellite, 27 satellite ground terminals, and 2 control centers. It has been operational since 1991, and provides communications in both the UHF and SHF bands.

NATO plans to retire the remaining NATO 4 satellite once it reaches the end of its life in 2004 or 2005. However, instead of purchasing and operating the next generation of satellites independently, the NATO Satcom Post-2000, as the new program is called, will involve purchasing capacity from existing European or American satellites as well as an upgrade of existing ground stations. NATO's NC3A leads the program.

The United Kingdom, France and Italy submitted a joint bid to supply SHF and UHF capacity from existing and planned national programs (Skynet in the United Kingdom, Syracuse in France, and SICRAL in Italy). The U.S. Department of Defense also made a bid, offering SHF capacity on its Wideband Gapfiller satellite system and the Defense Satellite Communications System (DSCS), and UHF capacity on the UHF Follow-On system and the Mobile User Objective System. Additionally, the United States proposed selling NATO EHF capacity on its Advanced Extremely High Frequency system, and France proposed EHF capacity on one of its Syracuse 3 satellites.

In May 2004, the NATO C3 Agency selected the joint British-French-Italian bid for the SHF and UHF parts of the Satcom Post-2000 program. The 15-year, \$549 million contract will include establishing a NATO Mission Access Center that will route all NATO SATCOM via satellites in the Skynet 5, Syracuse 3, and SICRAL systems. Beginning in 2007, the NATO system will be based on two Skynet 5, two Syracuse 3, and two SICRAL satellites. A selection

on the EHF part of the program, worth over \$200 million, is expected in 2005 (EHF capacity is not expected to be needed before 2010).⁶⁷

⁶⁷ Peter De Selding, "NATO Communications Program Merges 3 National Systems," *Space News*, May 10, 2004.

Recent C4ISR-Related Commitments

The transformation of NATO took a major step forward with the Prague summit of November 2002. First, and most important, the NATO agenda moved from a focus on Article 5 missions involving the defense of the NATO member countries, to a clear focus on Article 6, out-of-area missions. This shift in focus had been in the making since the 50th anniversary Washington summit of 1999, when the European allies largely resisted efforts by the United States to turn away from the defense of NATO Europe to threats from outside the NATO area. The shift came about for three reasons. First, NATO's experience in Bosnia, Serbia, and Kosovo (the first actual war conducted by NATO as an alliance) made it clear that the European defense mission had been superseded by responsibilities for peacemaking and peacekeeping at Europe's Balkan fringe. It also exposed a number of weaknesses and gaps in Alliance capabilities.

Second, 9/11, the war on terrorism, and the war in Afghanistan all involved the pursuit of a new adversary, whose transnational character made it a potential threat to all the allies, but whose global location necessitated military and other actions outside the NATO area. While NATO invoked Article 5 for the first time in its history the day after the 9/11 attacks on the United States, the Alliance was not initially involved in the war in Afghanistan, leading to some uncertainty about the intentions of the United States with regard to its allies (although several allies were included in the coalition of the willing in Afghanistan). However, NATO has been directly involved in post-war security operations around Kabul and, at the request of the UN, took complete control of the security operation around Kabul in August 2003. The International Security Assistance Force (ISAF) has been under General Jones and Allied Command Operations (ACO) ever since and is in the process of deploying to locations outside of Kabul in the form of Provisional Reconstruction Teams (PRT). This was a significant new, out-of-area deployment for many European countries and for the Alliance.

Third, the 9/11 attacks and what was presumed at the time to be a potential threat of weapons of mass destruction in Iraq, both focused NATO attention more squarely on the risk that hostile states or terrorist organizations might acquire such weapons and the means to deliver

them on NATO territory. As a result, new impetus was given the Alliance's planning around WMD operations and TMD programs.

These major security developments at the beginning of the 21st century brought renewed attention to defense spending and force planning in most of the major NATO allies, including the new members from the former Warsaw Pact. Persistent U.S. and NATO pressure on allied defense budgets led to a small but important reversal of course in the trend toward declining budgets in the United Kingdom, France, Italy, and the Netherlands, and considerable soul-searching about defense budgets and plans in Germany.

The nature of the new security issues has also intensified European concern about acquiring more modern defense technology, particularly transportation, logistics, and especially relevant to this study, C4ISR. The Balkans operations provided an impetus for the Europeans to plan more at the European level for peacekeeping and peacemaking operations (see below). Balkan deployments also exposed severe European shortcomings in lift, communications equipment, sensors for surveillance and reconnaissance, and data fusion.⁶⁸ Kosovo air operations exposed even more clearly the European shortfalls in secure communications to and among Alliance fighter aircraft, the inability to unify data sources for a common picture of the battlespace, and the dependence of the Europeans on intelligence derived from U.S. surveillance and reconnaissance assets.⁶⁹

⁶⁸ See Barry, "Transforming NATO Command and Control for Future Missions," 7. Barry notes that the CRONOS Windows-based NT information system in NATO was developed for IFOR in Bosnia. Thomas, notes significant C2 and communications problems in IFOR. CRONOS tended to be infected with viruses. The U.S. and United Kingdom could connect digitally, but the French and Germans had to be connected with an analog interface, with slower data rates. Secure communications were a problem, as was reaching down to the tactical level. A number of ISR systems were used, including JSTARS, Nimrod, the Atlantique, and C-160, but they could not cross-transmit data. Thomas, *The Military Challenges of Transatlantic Coalitions*, 43-45.

⁶⁹ Thomas, reports that the U.S. met 95% of the allied intelligence requirements in Kosovo, but data release was slow. French Horizon air surveillance assets could not be integrated, though French and German drones were useful. In addition, secure communications were a problem; aircraft communications had to be transmitted in the clear. Allied surveillance aircraft could not transmit directly to strike aircraft. Again, the United States and United Kingdom could connect more successfully. "Difficulties emerged between the Allies in sharing bandwidth, linking disparate information systems, establishing common standards for network security and passing on time-sensitive intelligence." Thomas, *The Military Challenges of Transatlantic Coalitions*, 52-53. See also *Les Enseignements du Kosovo: Analyses et References* (Paris: Ministère de la Défense, November 1999) and *Kosovo/Operation Allied Force After Action Report* (Washington, DC: Department of Defense, 31 January 2000).

Combat operations in Afghanistan and Iraq have intensified the pressure on the European allies to plan for defense transformation and more network centric operations. Both efforts made it clear just how far the United States had moved since the Gulf War in terms of agility, mobility, and information networking of its forces. Deployed European capabilities in C4ISR were dramatically less capable, and the alliance lacked the tools to advance interoperability rapidly. Moreover, despite having more than 2 million men and women under arms, the European allies only had a small expeditionary capability, largely in Britain and France. It has become increasingly clear that the military missions of the future, whether national, European, or transatlantic, would depend on a high state of readiness, advanced logistics, networked C4ISR, and a high degree of flexibility and agility. Only U.S. forces came close to meeting this test, with the British and French trailing and the other allies far behind.

Responding to these lessons, the Alliance made three significant decisions at Prague with major implications for the future of the alliance in the arena of network centric capabilities: the PCC, the creation of an NRF, and a major restructuring of the NATO command structure, bringing a new command—ACT—into existence. These NATO decisions could provide significant⁷⁰ incentive for the Europeans to move toward enhanced C4ISR and greater interoperability with the military forces of the United States

The Defense Capabilities Initiatives, the Prague Capabilities Commitments, and the Istanbul Summit

The Prague Capabilities Commitments (PCC) were adopted in 2002, in the face of manifest European failure to meet the many force and equipment planning goals set out at the 1999 Washington Summit in the DCI.⁷¹ The number of PCC goals to be met is actually larger than the DCI list, numbering more than 450. However, the NATO Secretary General at the time, Lord Robertson, identified eight as a priority focus, given their link to expeditionary operations

⁷⁰ Picavet briefing, February 13, 2003, slide 7.

⁷¹ Interviews. See also Gompert and Nerlich, *Shoulder to Shoulder*, 10: “DCI lacked a common strategic orientation, provided no doctrinal and institutional links to the U.S. force-transformation process, set no priorities, and failed to inspire allied investment in force modernization.”

including, in particular, C3I.⁷² In the C2 and communications arena, the PCC particularly targeted the lack of deployable C2 facilities, reconnaissance and surveillance assets, common interoperable intelligence organizations and systems architecture, and the shortfalls in the communications arena to link them together. They should provide a more measurable and reachable target for European force planning and acquisition. The 2004 Istanbul Summit further stressed the Alliance's need for measures to increase the deployability and usability of its forces, and the need for continuing the transformation process already underway. The final communiqué mentioned, in particular, the streamlined command arrangements (including the establishment of ACT), the NRF, and a commonly funded AGS program. Additionally, the summit resulted in a project to provide guidance on improving various NATO capabilities, including operational planning and intelligence. These were deemed crucial for the Alliance's current and future requirements, specifically for interoperable and deployable forces able to carry out operations and operate jointly in a complex security environment.

NATO Response Force

Although NATO has developed a number of common force packages and headquarters under the CJTF label, until Prague it lacked the capability to deploy a small, agile, and light intervention force, with the transport, logistics, and communications it needed to sustain itself. Such a force would clearly be intended for missions on short notice, outside the NATO area, to provide opposed entry, establish a foothold, and be the point of the spear for a larger NATO ground force to follow. The NRF was proposed to fill this gap. As its first commander, General Sir Jack Deverell put it, the NRF will be “an expeditionary capability, essential to respond to the globalization of terrorism and to contain future potential crises before they become unmanageable.”⁷³

⁷² Barry, “Transforming NATO Command and Control for Future Missions.” According to Barry, the overall PCC list includes more than 100 commitments related to C2 and information systems. Interviews suggest that in implementation, NATO is putting heavy emphasis on air defense, TMD, and C3I capabilities.

⁷³ James Jones, speech on the occasion of standing up the first prototype NRF units, October 15, 2003, from NATO web page. In addition, the force could do noncombatant evacuations, support counterterrorism, and assist with consequence management. The mission of the first force is to provide joint C2 at the operational level, including Turkish land forces, Spanish naval forces, and NATO air components. According to Deverell, some key enablers are not yet ready for this force: strategic lift, deployable communications, and information systems, among them.

It would consist of roughly 20,000 troops plus naval and air capabilities, drawn from the High Readiness Forces of the NATO members. With the lift, logistics, and modern, network-capable equipment, it could deploy within 5 days and be self-sustaining for 30. As planned, the NRF-designated forces would remain actively committed to this mission for a six-month period, at which time a new set of forces would become the NRF package, while the first group stood down and returned to a lower state of readiness.⁷⁴ The force would train and exercise together during the highly ready period. Because of its high state of readiness, it might be a force the Alliance could use more often than it might deploy its massive, heavier, slower capabilities.⁷⁵

The NRF has a deeper significance, however, in the view of some sponsors. While it is timely and costly to imagine overhauling all of European NATO's current forces for more agile, network centric capabilities, the NRF rotation scheme provides an opportunity to cycle those forces through a period of training, readiness and stand-down, one unit at a time. In addition, after only two years, some hope the Europeans will provide the enablers (lift, C3I, and logistics) currently supplied by the United States. In this way, training European forces for agile, flexible operations and equipping them with the enablers they need, including networked C3ISR would, over time, convert existing European military capabilities to a more modern, networked force. For some supporters, NRF constitutes an intense European upgrade program by stealth.⁷⁶

It is not clear that all the allies see this capability the same way. Not all are committed to cycle large elements of their land forces through the NRF and may choose, instead, to assign a smaller proportion of their forces to the NRF type of mission, and cycle them at a higher rate. Germany, for example, has made a decision to create three categories of forces, only the most

⁷⁴ Speech on same occasion. Supreme Allied Commander Europe, General James Jones described as "a joint/combined air, land, sea and special operations force under a single commander, maintained as a standing rotational force...available for immediate use."

⁷⁵ Hans Binnendijk and Richard Kugler, "Transforming European Forces," *Survival* No. 44 (2002): 117-132.

⁷⁶ From interviews. See also Klaus Becher, "Towards Strategic Dialogue in NATO: Europe's Condition," in C. Richard Nelson and Jason Purcell, eds., *Transforming NATO Forces: European Perspectives*. Compendium of papers presented at a conference on "Transforming NATO Forces: European Perspectives," October 18, 2002. (Washington, DC: Atlantic Council of the United States, 2003).25.

highly ready of which will be intended for the NRF. For some allies, this would avoid the expense of upgrading all their forces to NRF missions and capabilities over time.

Moreover, for some Europeans, the relationship between the NRF and the European Rapid Reaction Force (ERRF) is not clear. The relationship between the two will need resolution, given the limitations on budget resources. For some Europeans, NRF is seen as the last chance to work with the U.S. military on the more global military challenges and to engage the United States with European defense planning. For others, investment in the NRF competes with their commitment to the ERRF. Despite the views of some that the two are not incompatible, the assertion of this view does not make it so. This tension over rapid reaction force planning reflects a broader uncertainty about the transatlantic defense planning relationship. Over time, it will need to be resolved to ensure both types of forces can play their roles.⁷⁷

There also appears to be some difference of view over the extent to which U.S. forces will be integral to the NRF. European sources express a strong desire to have the United States participate directly in NRF training and exercising and for U.S. forces to be fully integrated into the NRF. American sources suggest, instead, that the goal of the NRF is to create a predominantly European capability for rapid deployment, which could lash up with a separate, interoperable, American force.⁷⁸

Clearly this difference of view could have implications for the C4ISR elements of the NRF. In the all-European case, C2, communications, and sensing assets could be entirely European, as long as the technology allowed them to plug and play with the United States, permitting the download of data, interoperable communications, and a common sense of the battlespace. The U.S.-engaged model could provide greater incentive for both forces to develop common equipment and software to ensure that the force could operate in a seamless way.

⁷⁷ Interviews in Paris, Brussels and London.

⁷⁸ From interviews.

The NRF is a major new NATO commitment. Some view its success or failure as central for the future of the Alliance, altogether.⁷⁹ The first, test bed elements of the force were stood up only a year after Prague, have held one exercise, and will rotate in the summer of 2004. Full NRF operating capability is expected by October 2006. The early training and exercises will test C4ISR requirement and reveal shortfalls that could provide incentive for European investment in the C4ISR arena.

Restructuring of Alliance Commands

The third Prague decision could have important long-term implications for the transatlantic relationship in C4ISR. The NATO command structure has now been substantially revised, with an Allied Command Operations in Europe and a new Allied Command Transformation in Norfolk, VA, with operations in Europe. The creation of ACT, combined with the change in NATO missions, will put a premium on the upgrades to NATO's C2 and communications infrastructure already noted.⁸⁰

ACT is responsible for transformation activities in NATO. It will support transformation planning, provide lessons learned to national planners, argue for NATO investment in transformational programs, write doctrine for network centric operations, and develop educational materials for NATO training, such as the Joint Warfare Center in Norway. It could play a central role in supporting and examining national C4ISR investments, making sure NATO's N3CA undertakes an active C4I program, and encouraging the European militaries to think and plan in a more joint mode.

Because the commander of ACT is dual-hatted as the Joint Forces Commander of the United States, ACT is positioned as a bridge between U.S. transformation and network centric thinking and experimentation and efforts to move up this ladder in Europe. It could provide a window into the U.S. transformation process for Europe.⁸¹ European military sources indicate a

⁷⁹ Interviews in Brussels.

⁸⁰ See Barry, "Transforming NATO Command and Control for Future Missions," 4.

⁸¹ Ian Forbes, CBE, "Transforming NATO Forces," in Nelson and Purcell, *Transforming NATO Forces*, 4.

high degree of interest in ACT programs and responsibilities, and a desire for a high degree of participation.

ACT holds great promise, provided its programs are implemented with priority attention in Washington, DC. It remains to be seen, however, how much priority the U.S. military services will put in on joint, networked and NATO-related activities as they develop forces for the U.S. military. It also remains to be seen if ACT will actually be given a role in the allies' and U.S. defense planning process, with the ability to review national-level C4ISR programs. ACT is only just getting underway, with an initial planning exercise on what a NATO Joint Vision for 2018 could look like. The jury is still out about its long-term impact on creating incentives both for European force transformation and for more intense transatlantic commitments to interoperability, especially in C4ISR.

Network Enabled Capabilities

At a meeting in November 2002, the NC3B announced the need to develop a NATO equivalent of the American NCW concept and the British NEC. The NC3B maintained that the first step in this process should be a feasibility study looking at the various technical and organizational issues such a concept would involve in a NATO context.

Led by the NC3A with the support of ACT, this feasibility study takes a more European view of transformation, opting for the terms “network enabled” and “capabilities” instead of the American “network centric” and “warfare”. Rather than wait for a joint NATO agreement on investments and organization of the NATO Network Enabled Capabilities (NNEC) study, nine NATO nations (Canada, France, Germany, Italy, the Netherlands, Norway, Spain, the United Kingdom, and the United States) agreed in November 2003 to jointly fund the study. Each nation has agreed to contribute €150,000 for a total of €1,350,000. The study is expected to be finished sometime in June 2005. Its major deliverable will be a roadmap for NATO to guide the creation of a network-enabled capability for its 26 member nations. It will take into account interoperability issues, commercial and technology trends, and relevant national assets (both

existing and planned). An important element in the study will cover how network enabled capabilities can be deployed by the NRF.

Conclusions

NATO as an organization has clearly worked hard to move its C4ISR capabilities into the 21st century. It has also strongly incentivized its members to move in this direction. While the traditional NATO force planning methods do not yet appear to support this effort, the specific decision to create the NRF could constitute a major step toward a transformed capability. NATO common programs for C2 and communications, including space communications, are being modernized. Several new R&T investment programs hold promise for a move toward a more integrated C2, communications, and sensor data architecture: ACCS, AGS, TMD, and CAESAR. Finally, the Prague decisions (PCC, NRF, and ACT) all could well point toward a significantly redefined alliance capability and major reshuffling of European member state investments.

There is, however, a fragile underside to this trend. U.S. policies and actions could undermine NATO's evolution. Should U.S. force planning and investment continue to be done on a largely unilateral basis or outside the framework of the alliance, the transatlantic C4ISR gap will be harder to bridge.⁸² For the Alliance to be incentivized, the United States will need to put interoperability at the center of its C4ISR planning process, which it does not currently do.⁸³ ACT will need to be seen by the United States as a priority effort, through which bridges can be built with European capabilities. U.S. decisions not to fund future rounds of ACCS, AGS, or TMD would weaken the opportunity to create a common European C4ISR architecture.

⁸² John Stenbit, "The New Challenges of Network-Centric Warfare," European Institute report, 909. In 2002, Stenbit, Assistant Secretary of Defense for Command, Control, Communications and Intelligence, implied a preference for acting outside the NATO context with respect to C3I interoperability decision: "I believe it is best thought of in bilateral and multilateral relations, not alliances. This is not a statement of position by the government. It is certainly not an implication that I think NATO has no role to play in the future. It is just that the dynamics of how these communities of interest are going to form and un-form, and around which changing sets of parameters, are quicker than the processes that NATO considers when looking forward. NATO prefers long-term, more stable planning."

⁸³ Charles Barry notes that "In the past, NATO interoperability features included in U.S. and allied equipment designs were easy prey when faced with trimming systems to meet budget constraints. In a future networked force, interoperability of forces and headquarters at every echelon becomes even more critical. American systems now include interoperability as a key performance parameter; however, interoperability is defined as *within U.S. forces*, not NATO interoperability." Barry, "Transforming NATO Command and Control for Future Missions," 9.

Continuing to distance the United States from participation in the NRF might undermine European willingness to invest seriously in that effort. A U.S. decision to delay, diminish, or cancel the F-35 Joint Strike Fighter, which has significant trans-Atlantic participation, would have a major impact on the willingness of the European allies to commit to common programs. Finally, continuing U.S. inactivity with respect to the reform of export control and technology transfer rules will further weaken any incentive European allies have to define transatlantic collaborative technology programs, inside or outside NATO (see below).

On the European side, there may also be trends that could undermine NATO's evolution. The development of defense capabilities in the framework of the EU is discussed below. While the EU program is not as advanced as the changes in NATO, if the Europeans move toward a defense vision and defense capabilities that are separate from NATO, some of the progress taking place within NATO could halt. There are important, positive reasons for the Europeans to create more autonomous European capabilities, but it will also be important to manage the evolution of the EU/NATO relationship so progress can continue in both frameworks. In addition, whether through the EU or NATO, a failure to allocate European fiscal resources to defense could seriously undermine the PCC, as well as the common efforts in ACCS, AGS and TMD. In addition, European allies could undermine the NATO effort by not investing in national systems that are compatible both with each other and with the emerging NATO system (see national sections of the study).

Although developments in NATO, as they impact on C4ISR and the emergence of a balanced transatlantic approach to network centric operations, appear promising, it would not take much for this trend to be reversed. A pattern of symbolic change in NATO could result which puts even greater distance between the C4ISR capabilities of the European allies and those of the United States

C4ISR at the European Level

The EU is beginning to emerge as a critical context for allied planning for defense operations, improving military capabilities, market development, procurement policy, defense industrial policy, and research in security-related technologies. While the EU defense agenda does not yet focus sharply on C4ISR and defense interoperability, it is moving inexorably in that direction.

U.S. policymakers tend to view transformation, network centric operations, and interoperability either solely within the U.S. context or as NATO issues. There is also a prevalent view in Washington that the European allies will remain technologically behind, will continue to rely on U.S. defense capabilities, will not invest adequate defense resources to catch up, and do not plan in the framework of a strategic vision that requires network centric defense capabilities. Such perceptions are misleading. This study suggests that Europe possesses a technological base adequate to meet modern C4ISR requirements, and its intention of developing those capabilities is becoming clearer. Moreover, the strategic vision in Europe, while different from that of the United States, clearly includes the desire for increased network centric military capabilities.

Policymakers in the United States need to be aware of these cross-European developments, as they are starting to shape European attitudes toward strategic mission, the development of rapid reaction capabilities, technological investments, and cooperation across the Atlantic. Over time, the rise of a defense-capable EU will change the context within which these issues are discussed.

Emerging Strategic and Defense Planning

European-level strategic thinking and defense planning have made significant strides since the Maastricht treaty was signed in 1991.⁸⁴ Initially, European militaries and defense

⁸⁴ See Adams in Cindy Williams, WEU report, other ISS-EU reports for background.

budgets shrank with the end of the Cold War, as occurred in the United States. Several changes marked turning points for Europe. The Maastricht Treaty committed the EU members to forging a Common Foreign and Security Policy (CFSP) and created the Second Pillar in the EU, involving political and security issues which the Council (representing the member states) would handle on an intergovernmental basis. The Treaty of Amsterdam, coming into force in 1999, went a step further, defining the CFSP as “including the progressive framing of a common defense policy...which might lead to a common defense.”

These EU developments, like those in NATO, have been stimulated and accelerated by the lessons Europeans have learned from the security dilemmas of the past decade: the manifest inability of French forces to interoperate with the United States in the first Gulf War, communications and interoperability problems among partners in the Bosnia peacekeeping forces (IFOR and SFOR), difficulties encountered coordinating the NATO air campaign over Kosovo, problems in force coordination in Afghanistan, and disagreements with the United States over the invasion of Iraq.

These events have given rise to a sense among many major European powers that they need a common, rapid deployment military capability which can operate on its own, either borrowing NATO assets or with the tools that would allow it to operate autonomously. While there are many disagreements on these intentions, a number of steps have been taken toward this goal:

- The 1999 Cologne European Council meeting set an EU goal of having “the capacity for autonomous action, backed up by credible military forces, the means to decide to use them, and a readiness to do so, to respond to international crises without prejudice to actions by NATO;”
- The 1999 European Council in Helsinki crafted an EU Headline Goal of creating a force of 50-60,000 that could be deployed within 60 days and supported for a year. The mission of this force would be the Petersberg Tasks: humanitarian and

rescue tasks, peacekeeping tasks and tasks of combat force in crisis management, including peacemaking;⁸⁵

- In the context of the EU Council of Ministers, the members created a Political and Security Committee to consider and act on foreign policy and security issues and manage crisis interventions; a Military Committee consisting of senior officers from the member states, which has command over military activities; and a Military Staff of roughly 150 based in Brussels to examine and shape military requirements for the Headline goal force;
- The EU has conducted an inventory of European national military capabilities relevant to the Headline Goal, and set objectives to meet the inventory shortfalls, held Capability Improvement Conferences to track commitments, and created the ECAP with nationally-led working groups to develop plans for meeting key shortfalls;
- The Laeken, Belgium Council of Ministers meeting in December 2002, declared that the EU had achieved the capability to conduct “some crisis management operations;”
- The EU has negotiated the Berlin Plus agreement with NATO, which allows the EU to have recourse to NATO assets to carry out crisis management operations when NATO is not involved;
- During 2003, the EU carried out a policing operation in Bosnia, a military peacekeeping mission in Macedonia, and a small peacekeeping operation in the Democratic Republic of the Congo (Operation Artemis).

⁸⁵ These tasks were defined at a WEU declaration made in Germany in June 1992, and were codified in the Amsterdam Treaty.

The EU reaction force emerging from the Headline Goal process is committed to missions that appear to be different from those being defined for the NRF, which is intended to be lighter and more rapidly deployable for early arrival in out-of-area missions. The European force, it is argued, was largely intended for humanitarian and peacekeeping missions.

The distinction between peacemaking missions included in the Petersberg tasks and the high-intensity combat, of which U.S. forces are intended to be capable, has been a gray area. To some, the EU force was distinct from the goal of creating a European high-intensity, network centric military capability. To others, the higher end of the Petersberg tasks would require a network centric capability.

With respect to C4ISR, however, the distinction between the two types of forces may not be significant. If any EU force is to be able to operate on a joint basis, C2 would have to cover the entire force. And, whether it is heavy and slow or light and mobile, the utility of ISR for the total force is unarguable. As noted below, the EU review of capabilities and the goals being set clearly point toward transformed and more network centric forces. Moreover, while the EU can make use of both national (currently German, British, and French; possibly Greek and Italian in the near future) and NATO operational headquarters (the latter under the Berlin Plus agreement) for controlling missions its forces carry out, these are all nonmobile assets. European military planners are aware that as things currently stand, a future ERRF would have to own the C2 and communications systems it will deploy in the field.

The distinction between the NRF and the EU force has been further eroded by the Franco-British agreement in 2003 that they would encourage the EU to develop a much more rapid, mobile response capability. The two countries agreed at Le Touquet in February 2003 that the EU needed to set new capability goals to improve their rapid reaction capabilities, with particular attention to the readiness, deployability, interoperability, and sustainability of such a force. The goal, further elaborated in London in November 2003, is to create a 1,500-person EU

force, built on the experience with Operation Artemis, which could deploy in 15 days, with appropriate transportation and sustainability.⁸⁶

While the EU has not agreed formally on this goal, there is a strong sense in Brussels that the Headline Goal force only gets part of the way toward the objective of rapid reaction and out-of-area operations to which the EU members are increasingly committed in the international security environment of the 21st century.⁸⁷ The evolution of the EU toward a new constitution suggests that a more ambitious EU goal is likely in the future. The final report of the Convention's defense working group, in December 2002, called for not only the Headline Goal force, but "smaller rapid response elements with very high readiness," including C2, intelligence, and reconnaissance.⁸⁸ In light of this goal, the working group asked "whether the [EU] capability objectives do not need to be revised in the light of the new threats."⁸⁹

The working group's concern about broader missions was also reflected in the recommendation that the Petersberg tasks be updated and broadened to include conflict prevention, joint disarmament operations, military advice and assistance, post-conflict stabilization and support for anti-terrorism operations in non-EU countries. It also recommended that some EU members might want to carry out more intense defense cooperation than that provided for in the Headline Goal force. Finally, the working group recommended that a European Armaments and Strategic Research Agency be created in the EU with a mission that included tracking the progress toward the interoperability and force readiness necessary to accomplish these wider missions.⁹⁰

These recommendations have proven not merely hortatory. The Constitutional Treaty for Europe of June 2004 repeated many of the themes the working group had suggested. The goal of

⁸⁶ See "Franco-British Declaration on Strengthening European Cooperation Security and Defence," Le Touquet, February 4, 2003, and "Franco-British Declaration on Strengthening European Cooperation in Security and Defence," London, November 24, 2003.

⁸⁷ Interviews in Brussels. See also European Union, "A Secure Europe in a Better World: European Security Strategy," approved by the Council December 12, 2003, at <http://ue.eu.int/solana/list.asp?BID=111>

⁸⁸ The European Convention, "Final Report of Working Group VIII – Defence," CONV 461/02, WG VIII 22, Brussels, December 16, 2002, 5.

⁸⁹ *Ibid.*, 15.

⁹⁰ *Ibid.*, 23-24.

what was called the Common Security and Defense Policy would be to create an operational capability, both civilian and military, to be used “on missions outside the Union for peacekeeping, conflict prevention, and strengthening international security in accordance with the principles of the United Nations Charter.”⁹¹ The last formulation is open to a particularly broad interpretation.

Consistent with this breadth, Article III-210 of the Constitutional Treaty amends the Petersberg Tasks to include “joint disarmament operations, humanitarian and rescue, military advice and assistance, conflict prevention and peacekeeping, combat forces in crisis management, including peacemaking and post-conflict stabilization.” It also tasks the proposed European Armaments, Research, and Military Capabilities Agency to help “identify the member states’ military capability objectives and evaluate observance of the capability commitments given by the member states.”⁹²

The EU Council of Ministers reached an agreement on a Constitutional Treaty for Europe in June 2004, which included the Union’s defense provisions. These reflect the broader defense mission discussed above and a commitment to building the defense capabilities to carry out that mission. The more ambitious and combat-oriented parts of this mission statement are a further indication of the need for more advanced C4ISR capabilities across the EU to carry it out, as well as including interoperable communications and intelligence capabilities that would make the force effective.

Focusing on Capabilities

It is premature to announce the arrival of a joint multinational force at the European level that is able to field common C4ISR assets. Such capabilities are not in place today, and the question remains whether the EU member states will commit the resources needed to upgrade and integrate the national capabilities discussed country by country in this study. While there is room for skepticism, given budgetary constraints in all member countries, an active process

⁹¹ Article I-40.

⁹² Article III-210.

continues to incentivize the EU members to make their forces and defense technology more modern, transformed, and interoperable.

The current strategic and defense planning commitments are being advanced through the Headline Goal and ECAP processes, which have identified capability shortfalls, set priorities for meeting them, and created a mechanism to define ways to meet them. The initial Headline Goal and evaluation led to the identification at the end of 2001 of 19 critical shortfalls and a working process for defining ways to meet those shortfalls. The ECAP panels, each chaired by a member state, include seven clearly relevant to C4ISR capabilities.⁹³ This first stage led to reports in March 2003, proposing changes to member state contributions or new acquisitions, to fill the capability gaps. The May 2003 Capabilities Conference then identified ten new groups to develop strategies for filling key shortfalls through acquisition, leasing, multinational projects, or role specialization, three of which deal with C4ISR capabilities: Headquarters (United Kingdom lead), UAVs (French lead), and space-based assets (French lead).⁹⁴

However, the ECAP process has been a voluntary one, not clearly linked to funding decisions and not clearly coordinated with the EU Military Staff. Moreover, it has worked largely in the context of the Headline Goal target, not with respect to the broader commitments discussed above. As a result, the EU Council decided in November 2003 to tighten the process, develop a clear roadmap and begin to identify objectives, timelines, and reporting procedures for each group.⁹⁵

Defense Industrial and Technology Base Planning

In November 2003, the European Council also plucked one item out of the constitution discussions and accelerated its implementation into 2004: the establishment of a European-level

⁹³ Burkhardt Schmitt, "European Capabilities Action Plan (ECAP)" (Paris, Institute for Strategic Studies of the European Union, 2003), at www.iss.eu.org/esdp/06-bsecap.pdf. Unmanned Air Vehicles/Surveillance and Target Acquisition Units, Deployable Communications Modules, Headquarters, Theatre Surveillance and Reconnaissance Air Picture, Strategic ISR IMINT Collection, UAV (HALE/MALE), Early Warning, and Distant Detection Strategic Level.

⁹⁴ Ibid.

⁹⁵ Ibid.

agency responsible for armaments policy and oversight on the capabilities process. This agency, tentatively known as the EDA, is the latest in a series of steps Europeans have taken to advance a European-level armaments policy. Most EU member nations are committed to fostering a healthier European defense industrial and technology base that can support a transformed military capability, including C4ISR technologies. The Europeans have three options for arming national or cross-national forces with modern defense technology. They can acquire advanced technology from the United States, much of which has happened. Buying American, however, has become increasingly unattractive, given the lack of reciprocal access for European firms to the U.S. defense market, the difficulties encountered with U.S. export control and technology transfer regulations and processes, and the consequences of buying American for the European industrial and technology base.⁹⁶

The second option would be to develop defense systems and technologies on a transatlantic basis. U.S. trade and technology transfer rules make this difficult, though the European industry is pursuing this option, as the strategic partnership of EADS and Northrop Grumman and the Thales Raytheon Systems joint venture suggest. However, European firms and governments have been concerned about the risk that their smaller firms could be swallowed up by larger American partners and with the potential loss of technology in a one-way flow to the United States

Third, the Europeans could strengthen their own defense industrial and technology base, both to supply their own defense technology independently of the United States, and to provide partnership and competition with U.S. companies.

There has been considerable and growing support in Europe for this third option over the past decade. To sustain a European defense industrial and technology base, however, requires removing the intra-European barriers to industry relations, investment and trade. Gradually, the European defense market is moving in this direction. The most important change over the past decade has been the development of multilateral institutions and processes which facilitate a

⁹⁶ For more detail on these issues, see Gordon Adams, "Taking Europe Seriously," in Center for International and Strategic Studies, *European Defense Industrial Consolidation: Implications for U.S. Industry and Policy* (Washington, DC: CSIS, December 2001), 30-34.

trans-European defense market and cooperative defense procurements. The decision to create the EDA may represent a critical breakthrough in this process, as it could empower the EU as a player in armaments policy, a role previously constrained by the terms of the EU treaties.⁹⁷

The emergence of a European armaments policy and market is critical to the prospects for success in the ECAP and in the European Security and Defense Policy (ESDP).⁹⁸ The harmonization of military requirements, the standardization of equipment to meet those requirements, the elimination of acquisition and research redundancies, and the achievement of budgetary savings will all be important for the Europeans to achieve interoperability among themselves or with the United States Efforts to create a defense industrial policy at the EU level, to harmonize rules governing requirements and defense trade, to create a framework for cross-European defense acquisition programs, and to create EU-level structures that can deal with arms market policies will all contribute to reaching these goals.

The process of elaborating a European-level arms market and industry policy has been underway for nearly a decade, but progress has been marked in recent years. In 1996, four European countries—France, Germany, Italy and the United Kingdom—created a Joint Armaments Cooperation Organization, known by its French acronym: OCCAR.⁹⁹ OCCAR was created to manage certain specific cross-European defense programs, including the HOT, Roland, and Milan missiles, Tiger helicopter, and, recently, the A400M transport aircraft. Its work has been based on intergovernmental agreements and has been restricted to joint programs in production, not research and development. OCCAR is not an EU entity, but as interest has grown in an EU-level armaments policy, other EU members have joined (Belgium) or intend to do so (Spain, Netherlands, Sweden). It has gradually emerged from the shadows, with legal status in 2001, and is seen by many as a precursor of a European armaments agency.¹⁰⁰

⁹⁷ For further discussion of a European armaments policy, see Burkhardt Schmitt, *The European Union and Armaments: Getting a Bigger Bang for the Euro*, Chaillot Paper No.63 (Paris, Institute for Security Studies of the European Union, August, 2003), and Schmitt, *European Armaments Cooperation: Core Documents*, Chaillot Paper No. 59 (Paris: Institute for Security Studies of the European Union, April 2003).

⁹⁸ As Schmitt put it in ISS-EU Chaillot Paper No.63: "...no matter how CFSP and ESDP develop, it remains a fact that future military operations will normally be multilateral, and that standardization of equipment will become ever more important."

⁹⁹ Of Organization Conjoint pour la Cooperation en Matiere d'Armament.

¹⁰⁰ See Commission report of 2003.

In 1998, the six largest arms producers in Europe—the United Kingdom, France, Germany, Sweden, Italy, and Spain—signed a Letter of Intent (LOI) to carry out specific steps to make trans-European defense industry restructuring and business activities easier to carry out. The LOI covered security of defense supply, export control processes, security of information, military research and technology, technical information, and harmonization of military requirements. The six subsequently negotiated a Framework Agreement and Implementing Arrangements, which will become operational in 2004. The LOI harmonization process is also not being conducted in the EU framework and is clearly intergovernmental—it creates no new European-level structure or organization. The LOI goal is to make national rules and procedures in these areas compatible with each other, not to harmonize standards or policies. However laborious the process, however, it has put national bureaucracies in close contact with each other in the search for policies which will integrate the European market and national defense planning.

Concern about armaments policy has also grown within the EU itself. Article 296 of the Amsterdam Treaty was invoked for years as a way to keep national armaments policies off the EU agenda.¹⁰¹ In the Council of Ministers, an ad hoc working group on Armaments Policy (POLARM) was created in 1995. Its impact was limited until recent years, but, with the emergence of interest in the EDA, its activities have grown.¹⁰²

The European Commission (the supranational secretariat) has also gradually intruded into this policy area, despite member state reluctance to have them play a central role.¹⁰³ Since 2000, the Commission has authority over dual use export controls in the EU, though national governments still define the contents of the list (through other international agreements), and continue to govern purely military exports. Second, the Commission has begun to speak out on

¹⁰¹ The Article provided, among other things, that “any Member State may take such measures as it considers necessary for the protection of the essential interests of its security which are connected with the production of or the trade in arms, munitions and war material...”

¹⁰² See Schmitt, Chaillot Paper 63, p.32.

¹⁰³ Interviews in Brussels.

armaments and defense market policies.¹⁰⁴ It has also encouraged private sector activities which would support the emergence of a stronger EU policy in this area.¹⁰⁵ Finally, as noted in the chapter on space systems, the Commission plays a lead role in dual-use space programs such as Galileo.

This Commission activity has focused attention on the interoperability question. The STAR 21 report of 2002, conducted with significant EU participation, paid specific attention to defense needs, with the goal of enhancing European interoperability, both in the EU and NATO contexts, and ensuring European autonomy from the United States, if needed.¹⁰⁶ The Commission's 2003 communication on armaments policy, argued strongly for a "genuine European Defense Equipment Market," to provide economies of scale, greater acquisition bargaining power and, especially, to meet the needs of interoperability.¹⁰⁷

The 2003 decision to accelerate the EDA promises to bring many of the European-level initiatives together. The proposal had received support for several years from study groups and some governments, but received particular impetus from the Franco-British summit of 2003 (see above), the Thessalonica summit of June 2003, and the work on the European constitution, all of which strongly endorsed the creation of an agency that would monitor the achievement of the EU capability goals, set an agenda for longer-term capabilities development, elaborate a European-

¹⁰⁴ See Commission of the European Communities, *Communication from the Commission: Implementing European Union Strategy on Defence-Related Industries*. COM(97) 583 final (Brussels: Commission, December 4, 1997), and Commission, *Communication from the Commission: European Defence – Industrial and Market Issues – Towards an EU Defence Equipment Policy*, COM(2003) 113 final (Brussels: Commission, March 11, 2003).

¹⁰⁵ See European Commission, Directorate for Enterprise, *STAR 21 Strategic Aerospace Review for the 21st Century: Creating a Coherent Market and Policy Framework for a Vital European Industry* (Brussels: European Commission, July 2002). The STAR 21 group included seven top industry executives from the European industry and five EC commissioners, plus the Council's High Representative/Secretary General (Javier Solana). See also the joint declaration put out by EADS, Thales, and BAE Systems in April 2003, calling for the creation of a European armaments agency and greater research support on "networked capability, using information superiority, linked to precision attack systems," to achieve interoperability with the United States.. EADS, "Joint Declaration of BAE, EADS and Thales: It's Time to Act," April 28, 2003.

¹⁰⁶ The report deals with defense in chapter seven, pointing out that military requirements needed to be harmonized and R&D shared at a European level: "Unless Europe can build its own independent capability in this area [UAVs]...there will be severe limitations both in terms of being able to play a significant role in military operations alongside the U.S. or, most significantly, being able to mount independent actions. The key issue here will be interoperability among the European countries as well as with the U.S. and NATO." 29, 30.

¹⁰⁷ To achieve interoperability, the Commission argued, "in a cost-effective way, the solution would be to equip the national units that make up these forces increasingly with the same equipment." Commission 2003 Communication, 6. See also 10, 12.

level armaments and defense industrial and technology policy, and play a role in cross-European R&D spending.¹⁰⁸

The EU Council of Ministers decided to ask the Council staff to plan the implementation of EDA well ahead of the schedule for ratifying and implementing the proposals for a new EU constitutional charter. The mission of the agency was elaborated in some detail in November, covering operational requirements, strengthening the industrial and technological base of the defense sector, help to define a European capabilities and armaments policy, and help the Council evaluate the improvement of military capabilities.¹⁰⁹

The Council decision created an Agency Establishment Team under High Representative Solana to present proposals by April 2004 for decisions in June. The proposal will include the structure and organization of the agency, its internal working methods, its working relationship with the Council and the Commission, ties with the work of OCCAR and the R&D programs created under the auspices of the Western European Union (WEU) (see below), its budget, administration and staffing. It will also outline a first operational program for the agency in the fields of capabilities development, armaments cooperation, industrial and technology base policy, research promotion, and potential plans for creating a European defense market.¹¹⁰

The Establishment Team of 12, led by British civil servant Nick Whitney, began work in February 2004. Initial indications were that they would propose a relatively small agency, directed by a steering committee of ministers of defense, and funded by joint contributions to an administrative fund. There is also likely to be a second funding pool for defense R&T studies. Existing multilateral procurement activities, such as OCCAR, are expected to be absorbed slowly.¹¹¹

¹⁰⁸ On EU and WEAG/WEO R&D spending, see below.

¹⁰⁹ Council decision of 17 November 2003 “creating a team to prepare for the establishment of the agency in the field of defence capabilities development, research, acquisition and armaments,” 2003/834/EC, *Official Journal of the European Union*, 3 December 2003, L 318/19-21.

¹¹⁰ Ibid.

¹¹¹ See Brooks Tigner, “EU Acquisition Central?: Agency Would Coordinate Arms Buys,” *Defense News*, February 2, 2004, p.4.

The road to a coherent EU-level armaments policy, focused on the mission of transformed military forces and interoperability, remains a long one. The new armaments agency could play a critical role on this road, defining capabilities goals more broadly than the Headline Goal, including substantial attention to network centric C4ISR capabilities, supporting research efforts to support those goals, ensuring national governments realign their budgets to acquire the key technologies and systems, coordinating national acquisitions, and providing a central point for the realignment of the European defense market to acquire those capabilities more efficiently. The initial approach to the agency falls short of this goal, but, once established, it may develop the capabilities needed to perform these tasks at the European level, as other EU-level policy institutions have done.¹¹²

All of this will take time, however, given the normal pace of the European integration process and the reality that the EDA will be an intergovernmental agency. The member states will inevitably seek to restrain the Agency's activity, unless it is given substantial degrees of autonomy, including an autonomous budget. The linkages between its capabilities functions, its evaluation functions, its research support, and its procurement functions will need to be made clearer. The relationship with the Commission, which manages its own research program and has responsibilities for industrial, research, competition, and trade policy, will need to be carefully defined. And there will be a complex task harmonizing its work with the ongoing responsibilities and authorities of existing non-EU organizations and efforts, such as OCCAR, the LOI process, and the research activities of the Western European Armaments Organization (WEAO) and the Western European Armaments Group (WEAG).

European Defense Research and Technology Programs

One of the keys to effective action will be policy and investment at the European level in defense R&T. In a technological age, spending on defense R&T is a key indication of defense capabilities. The United States outspends the European NATO allies by a ratio of 4:1 on total

¹¹² One EADS official has noted that "we're happy they're starting out small and cautious. Anyone familiar with the evolution of EU institutions knows that, given enough time, these grow into their intended role. It may take 10 years, but EDA will grow." Same.

defense R&D—(see following table)¹¹³. Moreover, the United States has an explicit focus on investment in network centric technologies, military transformation, and C4ISR, whereas European-level policy and action on defense R&D, let alone on C4ISR, is in its infancy. Finally, European defense R&D spending is poorly coordinated across national lines and highly redundant, meaning that adding all national spending together gives a result much smaller than the arithmetic total implies; total European defense R&D spending is, in effect, less than the sum of its parts.

Table 9. EU Defense Expenditures by Member

	Total defense expenditure (in millions of constant 1999 U.S. \$)*	Defense expenditure % of GDP (based on current prices)*	Total defense R&D expenditure**	% of defense expenditure spent on R&D**
Austria	1598	0.8	10	0.66
Belgium	2538	1.3	1	0.05
Denmark	2256	1.6	1	0.04
Finland	1598	1.2	8	0.59
France	27730	2.5	3145	12.97
Germany	23406	1.5	1286	6.38
Greece	3290	4.3	26	0.81
Ireland	681	0.7	0	0.00
Italy	18236	2.1	291	1.96
Luxembourg	169	0.9	0	0.00
Netherlands	6204	1.6	65	1.21
Portugal	1222	2.1	4	0.32
Spain	7896	1.2	174	2.63
Sweden	4230	2.0	103	2.58
U. K.	36096	2.4	3986	12.22
EU total	137150		9100	
EU average	9143	1.75	607	7.55
U.S.	329658	3.4	39340	13.83

Source: European Union, International Institute for Strategic Studies and NATO

* Figures are for 2002

** Figures are for 2001

¹¹³ This ratio is expected to be closer to 5:1 following the increases in the U.S. defense budget for FY03 and FY04.

Overall, most EU countries are still under spending on all R&D, not only on defense-related R&D. Despite the 2002 European Council decision to achieve 3 percent of GDP spent on R&D in each of the member states by 2010, current growth rates will lead to a level of only 2.3 percent by the target year. Only two European countries (Sweden and Finland) currently surpass the 3 percent target, and the EU average is still just under 2 percent (compared to 2.7 percent in the United States).¹¹⁴ In defense R&D, the trend is even lower; in 2001, the member states of the EU spent slightly over \$9 billion on defense-related R&D, or 7.5 percent of the average defense budget (compared with almost 14 percent of the overall U.S. defense budget which were spent on R&D during the same year).

Article 296 of the Amsterdam Treaty has made it difficult for the EC to address this problem. Only in cases where trade or R&T investment in dual-use items distorted the operations of the civilian common market was the Commission authorized to intervene. In the past, it was slow to act even in cases such as these, due to the sensitivity of some member states. These constraints have left investments in defense R&T exclusively the domain of the member states, with work carried out largely at the national level or, if multinational, outside the EU framework.¹¹⁵

One of the major European-level defense technology R&T initiatives has been the WEAG of the WEU. WEAG was created when the WEU absorbed the Independent European Programme Group (IEPG), which between 1976 and 1992 had acted as an armaments procurement cooperation forum for all of the European NATO countries (except Iceland). Since its establishment, WEAG has been involved largely with collaborative defense R&T programs among its member countries, but has also examined the harmonization of defense requirements and opening national defense markets to European-wide competition. There are currently 19 member countries, including all non-NATO EU member states.¹¹⁶ The annual budget in the past

¹¹⁴ European Commission, *Third European Report on Science and Technology Indicators* (Brussels, 2003), 48, 52.

¹¹⁵ Andrew D. James and Philip Gummett, *European Defense RTD in Context* (University of Manchester: Policy Research in Engineering, Science and Technology, 1998).

¹¹⁶ A special agreement, known as the System Of Cooperation for Research And Technology in Europe (SOCRATE), was created in 1998 to enable Finland and Sweden (at that time not WEAG members) to participate in

few years has averaged about €100 million. WEAG defense technology R&T is handled under Panel II of the organization (Panel I being in charge of cooperative equipment procurement, and Panel III of policies and procedures to enhance collaboration). Under this panel there exist several instruments for collaborative R&T.

The first WEAG Panel II instrument, formed in 1989, was the European Cooperation for the Long Term in Defense (EUCLID). EUCLID cofunds projects—proposed by government representatives—that are jointly funded by the governments that wish to participate and by the private sector participants. The work is carried out by an industrial consortium formed from at least one company from each of the participating nations. EUCLID includes 13 technology areas, called Common European Priority Areas (CEPA). These include such network-oriented technologies as UAVs and robotics, military space technologies, and advanced communications. Each CEPA has its own Lead Nation appointed by WEAG Panel II, responsible for reporting on its activities, and an industrial team of leading companies in the sectors it covers.

The second WEAG instrument is the Technology Arrangement for Laboratories for Defence European Science (THALES). Signed in November 1996, it facilitates cooperation between government-owned or government-sponsored defense research agencies, although governments may choose to designate a private-sector entity to undertake work under specific projects. The collaborative projects in the THALES framework are Joint Programs (JP), established within the EUCLID CEPAs in a manner that is identical to that in which EUCLID collaborations are formed. Each of the participants in the JP is responsible for placing contracts or making arrangements at the national level.

A third mechanism, EUROFINDER, is a bottom-up program in which industry can propose R&D projects and receive cofunding for them. Proposals need not be associated with any particular WEAG CEPA, but since they are required to address national defense R&T strategies set out by governments, they are often aligned with particular technology areas. Once a year, proposals are received from industry and evaluated by the WEAG nations, who decide

WEAG R&D projects conducted under the framework of EUCLID and THALES. Later, SOCRATE was amended to allow the participation of Austria, the Czech Republic, Hungary, and Poland.

which ones to fund. Each EUROFINDER program is cofunded by the governments that wish to participate and by the industrial participants. The work is carried out by an industrial consortium formed of at least one company from each of the nations that take part in the program. Since the start of the EUROFINDER program in 1996, 188 proposals have been received, of which about half were retained for funding.

The last WEAG mechanism, the European Understandings for Research Organisation, Programmes and Activities (EUROPA), was created in May 2001. It enables any two or more signatories to propose the creation of a European Research Grouping (ERG) to carry out one or more individual or collaborative R&T projects with a relatively large degree of flexibility not offered by the EUCLID or THALES. Membership in ERGs varies.¹¹⁷ EUROPA also requires WEAG members to provide information on a regular basis about all areas of defense R&T in which they are prepared to cooperate with each other. This information is then used by WEAG to identify opportunities for cooperation and to warn of duplicative work undertaken at the European level.

Since its creation, WEAG has been quite successful in fulfilling its task of providing a discussion forum on European armaments cooperation. Since its member states each have an equal vote, the creation of a cartel of countries with strong defense industries that impose their aims—and prices—on others has been prevented. In terms of implementing actual R&T projects, however, its accomplishments have been much more modest. This is due both to its membership—it is composed of both producer and consumer countries with very different requirements and technological capabilities—and to the fact that decisions must be taken by consensus. The fact that all participants' requirements are taken into account prevents discussions and resources being focused on projects that will benefit only a small number of countries (such as projects related to power projection and the development of technologies for out-of-theater operations).¹¹⁸

¹¹⁷ The first ERG, referred to as ERG No. 1, was created by 14 countries in late 2001.

¹¹⁸ Assembly of WEU, "Arms Cooperation in Europe: WEAG and EU Activities" (Brussels, 4 December 2002).

The WEAO is another European-level defense technology R&T initiative operating under the WEU. Created by WEAG defense ministers in 1996, WEAO provides member countries with a variety of services in the area of military R&T, including administrative support to the WEAO Board of Directors and WEAG Panel II and legal assistance for countries signing R&T collaboration agreements for specific WEAG projects. The ability of WEAO to implement WEAG decisions on defense R&T—it has the authority and the necessary legal power to place contracts—has led to an improvement in this field. By 2001, it had facilitated the creation of 120 projects with a total of 500 million euros in funding.¹¹⁹

Over time, the EC has become another major player in European-level R&D. Since 1983, the Commission has managed its own civilian collaborative R&D program known as the Framework Program (FP). Currently, the FP is in its 6th round of 4-year cycles of funding, with €17.5 billion set aside for the funding of projects in various technology fields between the years 2003 and 2006. Organizations—firms, universities and/or government agencies—wishing to receive FP funding create R&D consortia (made up of a minimum of three partners, at least two of which are from European member states) and together submit project ideas in response to Commission calls for proposals. Such consortia may also include participants from various non-EU states (known as Associated States), such as Switzerland, Norway and Israel, which have signed collaboration agreements with the EC. The Commission funds 50 percent of project costs of the winning consortia. FP projects are currently legally restricted to cover only civilian technologies, but very often include areas of research with potential dual-use and military applications such as aerospace, energy (including nuclear energy), life sciences and information technologies. In the first annual work program of FP6 announced in 2002, proposals were called for in the fields of intelligent vehicles and aircraft, interoperable information and communications networks, end-to-end SATCOM systems, and data fusion, among others. It has been estimated that approximately one-third of the projects funded by FPs can be classified as dual-use projects.¹²⁰ Thales, EADS, British Aerospace, and many other European defense firms are all active participants in these FP projects.

¹¹⁹ See: WEAG Rome Declaration, 16 May 2002.

¹²⁰ European Commission. *The Challenges Facing the European Defence-Related Industry: A Contribution for Action at European Level* (Brussels, 1996).

Given the broader evolution of EU policies on armaments, the Commission is slowly adding security and military technology projects to its existing funding programs. In 2003, the Commission initiated a process to include defense technologies in the FP. Once fully implemented, this process will lead to additional public funding for European defense R&T. The first defense technology projects will be funded in 2004, grouped under the umbrella of global security technologies to sidestep the FP restrictions on funding military research. Capital will be provided through a combination of Commission funds, national ministerial budgets (whether defense, industry or other), and industry contributions.¹²¹ Some \$75 million will be invested in these projects during the first year, with a focus on border and coastal surveillance, aviation security, detection of biological and chemical agents, situation awareness, and satellite intelligence.¹²²

¹²¹ *Defense News*, "EU to Shift Research Funds Into Defense". May 19, 2003.

¹²² *Defense News*, "EU to Unveil First Defense Research Projects". October 13, 2003.

Space Systems and European C4ISR

Space systems have become increasingly important for managing military forces and combat operations and are being closely integrated into the military C4ISR architecture. From C2, through military communications and intelligence gathering, to weapons targeting, space-based systems have become a key part of military capabilities. U.S. military forces are dependent on space assets for global awareness, communications, and combat operations. Increasingly, European countries are also researching, testing, and deploying such capabilities as a central ingredient of national and trans-European C4ISR capability.

We have singled out space capabilities in this report for separate discussion, in large part because European programs in this field are not only growing, but also increasingly based on transnational cooperation and on an attempt to achieve interoperability through non-NATO agreements and arrangements. This trend makes space a significant European security (and dual-use) investment which could, over time, enhance European autonomy from U.S. defense operations and increase trans-European interoperability, while providing nodes for transatlantic interoperability as well.

The Roles of Space Systems

Satellite systems offer numerous benefits to military and intelligence forces. COMSATs provide broad geographic coverage and are relatively secure from attack.¹²³ Since the first geosynchronous satellites were launched in the 1960s, COMSATs have proliferated and communication by satellite has become a staple of the global communications industry. SATCOM requires only a few ground stations to maintain functionality, and with modern electronics, satellite transmitters and receivers are relatively portable.¹²⁴

¹²³ Arthur C. Clarke first recognized in the 1950s that three satellites in geosynchronous orbit, spaced equidistant along the equator, could provide worldwide communications coverage between the latitudes of about 60°N and 60°S.

¹²⁴ In the 1990s, Iridium, the first fully functional polar-orbiting satellite communication system, was launched. Polar-orbiting satellites provide communications at high latitudes, but compared to geosynchronous systems, they are extremely complex and expensive to build, launch, and operate. Iridium was a technical success but a commercial failure, and is now owned and operated by the U.S. Department of Defense.

France, the United Kingdom, Italy, and Spain operate dedicated or partially dedicated military geosynchronous satellites for military communications. Germany currently leases time on commercial satellites. It and the other major countries are planning dedicated military satellites in the future. Currently, no European country operates the necessary trio of dedicated military COMSATs to achieve global coverage (between 60°N and 60°S).

Only the United States has global coverage, both through its ownership of the low-earth orbit Iridium series and through its various geosynchronous satellites. Other nations rely on leased commercial capacity to provide coverage where their own military COMSATs cannot reach. The United States leases substantial commercial satellite capacity for nonsensitive communications, and relies on Milstar and other satellite systems for secure transmissions. Commercial systems are not as secure as the ones dedicated to military use, and there are other issues related to the commercial marketplace that complicate their use for military purposes.¹²⁵

Space also offers significant advantages for reconnaissance and surveillance. The United States and the Soviet Union first orbited reconnaissance satellites during the height of the Cold War in the 1960s.¹²⁶ In the mid-1970s, digital electro-optical systems flying in polar orbits allowed operators to image any place on Earth and return the images by means of electronic transmission, thereby increasing satellite flexibility and longevity.¹²⁷ However, these highly sophisticated digital cameras are hampered by clouds and dark of night. Hence, more recently, SAR systems operating at microwave frequencies have been developed. Although SAR satellites provide imagery with reduced sharpness compared to the best electro-optical systems, they can pierce through cloud cover and darkness.

In Europe, only France currently operates dedicated reconnaissance satellites, Helios 1 and 2. However, France, Germany, Italy, and the United Kingdom are all developing electro-

¹²⁵ Business practices and interests may at times conflict with military objectives. See, for example, John C. Baker, Ray A. Williamson, and Bret Johnson, "U.S. Security Interests and Dual-Purpose Satellite Technologies," in Ray A. Williamson, ed., *Dual-Purpose Space Technologies: Opportunities and Challenges for U.S. Policymaking*, (Washington, DC: Space Policy Institute, 2001), chapter 2.

¹²⁶ These first "spy satellites" used panchromatic and infrared film, dropped to earth in sealed containers from satellites for processing and analysis.

¹²⁷ In the civilian world, the development of such satellites was led by NASA with the creation and launch of the Landsat series of satellites, beginning in July 1972.

optical and SAR reconnaissance satellites. The United States operates highly sophisticated reconnaissance satellite systems, the exact technological capabilities of which remain highly classified. The United States and other countries also rely on high-resolution commercial remote sensing satellites to satisfy part of their need for routine reconnaissance data.

The United States also operates a series of surveillance satellites that monitor the globe for signs of a missile launch, as well as other SIGINT satellites for monitoring communications and electronic transmissions around the world. The latter, especially, have been reportedly put to use to detect communications from would-be terrorists. No European countries currently operate such systems, though French defense planners are in the early stages of developing their own SIGINT and missile warning systems, which currently include several pilot projects already in orbit.

Digital technologies have revolutionized the handling of data and information from space systems, allowing analysts to merge digital imagery maps with data from UAVs, AWACS aircraft, and other sources to create powerful information products that give field commanders improved awareness of the battlefield and enhanced capabilities for defeating the adversary. All of this information can now be transported regionally or globally quickly and efficiently by COMSATs. The EU Satellite Centre (EUSC) in Torrejón, Spain (established in 1991 as the WEU Satellite Centre and transferred to the EU in 2002), provides the EU with an analysis of earth observation space imagery to support decisionmaking in foreign and security policy issues. It currently handles space imagery received from the French SPOT, the U.S. Landsat 4 and 5 and Indian IRS-1C and D satellites, as well as from Russian commercial satellites. Within the next few years, it will also begin collecting and analyzing data from additional space-based systems, including Helios 2 and SAR-Lupe.

The sophistication and quality of European space technology is very high and growing fast, driven primarily by civil and commercial needs. Ultimately, the development of C4ISR space systems will depend on how much money European countries are willing to direct toward space systems from their relatively limited defense budgets. On the European level, it will also depend on the extent to which the individual countries are willing to cooperate and share

resources. As noted below, the initial signs are encouraging, particularly in SATCOM and earth observation, and underscored by the robust attempt to create a resilient space policy led by the EU and carried out by the ESA as well as by the member states. Nevertheless, funding constraints and the burden of legacy systems may continue to limit investment in space systems.

Changing Attitudes Toward European Military Space Systems

As recently as a few years ago, most military analysts in Europe doubted that Europe would develop much of a military space presence within the first decade of the 21st century. Only France, the European leader in space activities,¹²⁸ was beginning to press forward with a military modernization effort that included significant space elements. Over the past several years, however, European interest in the security uses of space has grown significantly. Events, both internal and external to Europe, have contributed to this changing perspective on the uses of space for military purposes:

The Galileo Position, Navigation, and Timing system

Driven in its inception almost entirely by a political desire for greater commercial autonomy and reliability, Europe has pressed forward with this independent position, navigation, and timing (PNT) system, which will duplicate the capability of the U.S. GPS. Galileo will be very much a dual-use and trans-European capability. Its development is led jointly by the EC Directorate General for Transportation and ESA, which is by charter civilian in character. However, the military utility of Galileo has not gone unnoticed by Europe's defense departments, which now depend heavily on the U.S. GPS for PNT services. The French military, especially, has funded research on the potential military capabilities of Galileo. It plans to use both Galileo and GPS in future operations. Other European countries are also considering similar policies and are likely to follow suit. The EU is also planning to use Galileo in support of the ESDP.

¹²⁸ Laurence Nardon, "France Cedes Leading Role in Space to Europe," *Global Politics*, April 2001, accessed at: <http://www.brookings.edu/fp/cusf/analysis/space.htm>, 4 March 2003. More recently, this leadership has begun to shift toward the EU.

Galileo is currently proposed to include 30 satellites and begin offering its services in 2008. The EC and ESA have invested a total of €1.1 billion in the development of initial technologies and in the building of experimental satellites. Another €2.3 billion will be spent on building and launching the full constellation of satellites and to prepare for commercial operations. A winning consortium to run the project is expected to be announced in September 2004, and a contract with the EC is to be signed in late 2005.¹²⁹

Europe's Global Monitoring of Environment and Security Program

Global Monitoring of Environment and Safety (GMES) is an ambitious program focused primarily on the pursuit of sustainable development and environmental management. It is Europe's approach to overseeing global as well as regional environmental issues. Like Galileo, GMES was initially conceived as a civil program. Security considerations were later included because the Earth observation systems involved can make considerable contributions to European security in the military field as well as the environmental one. Another element that GMES shares with Galileo is that both are managed jointly by the EC and ESA, with participation from various other European organizations and firms. If successful, GMES will provide sharply improved, better coordinated European capabilities to observe and analyze the environment and human activities on Earth, using both new and existing earth observation systems. GMES is fundamentally a strategy for organizing and utilizing Europe's many already existing and planned earth observation systems.

The GMES program is undertaken in two phases. The first, or initial, period (undertaken between 2002 and 2003) examined the current strengths and weaknesses of the European capacity for space-based environmental and security monitoring and identified the areas that required further investment and research. The second, or implementation, period (undertaken in 2004-2008) involves the initial development of infrastructures and capabilities identified in the initial period. Thus, in the near term, GMES will develop new information systems and techniques to exploit Europe's existing space-based earth observation capabilities more

¹²⁹ Peter De Selding, "Galileo Managers Committed to Deadline," *Defense News*, 14 June 2004.

efficiently. In the longer term, it will serve as a guiding program for planning new earth observation systems.

Although focused primarily on European environmental and security concerns, the satellite contributions to GMES are to be global in scope.¹³⁰ Europe is still working out the detailed focus and scope of the security aspects of GMES, but discussions are trending toward a more activist interpretation of the so-called Petersberg Tasks—humanitarian relief, rescue, peacekeeping, and crisis management—than a strict reading might suggest.¹³¹ Some of the capabilities developed in the global GMES program could be used, for example, to enhance Europe’s warfighting efforts far from its borders. In particular, the broader earth observation and analysis capabilities provided by GMES will prove extremely useful for the European military and intelligence community, especially when combined with reconnaissance information provided by both the dedicated security and the explicitly dual use earth observation space systems currently undertaken in Europe (see below).

European Space Policy in the EU Framework

In January 2003, the EC published a draft Green Paper on space for discussion, revision, and adoption by the EU states, various European publics, and ESA. After a series of formal consultations, the Green Paper was finalized in November 2003 as a White Paper,¹³² laying out a proposed European space policy, including defense uses of space:

“Europe needs an extended space policy, driven by demand, able to exploit the special benefits space technologies can deliver in support of the Union’s policies and objectives: faster economic growth, job creation and industrial competitiveness,

¹³⁰ Most remote sensing satellites orbit in polar orbits, which take these satellites over the entire earth as it turns beneath them.

¹³¹ “These tasks were established in June 1992 at the Ministerial Council of the Western European Union held at the Petersberg Hotel, not far from Bonn. On this occasion, the WEU Member States declared their readiness to make available military units from the whole spectrum of their conventional armed forces for military tasks conducted under the authority of the WEU...These tasks are today expressly included in Article 17 of the Treaty on European Union and form an integral part of the European Security and Defence Policy (ESDP).” <http://europa.eu.int/scadplus/leg/en/cig/g4000p.htm>

¹³² http://europa.eu.int/comm/space/whitepaper/whitepaper/whitepaper_en.html

enlargement and cohesion, sustainable development and security and defence.”¹³³

[Emphasis in original]

The White Paper also refers explicitly to the uses of space systems to support the Union’s CFSP and its ESDP. Further, the very existence of a successful Galileo, usable by the entire world, will be a visible symbol both of growing strategic independence from U.S. policies, and also as a more unified Europe, offering the perspective of future European success in space.¹³⁴ A successful GMES will add to both, strengthening the visibility and acceptance of expenditure on space systems within Europe.

Space and Space Technologies in the EU Constitutional Treaty

Article III-150 of the recently agreed-upon Constitutional Treaty for the EU states: “To promote scientific and technical progress, industrial competitiveness and the implementation of its policies, the Union shall draw up a European space policy. To this end, it may promote joint initiatives, support research and technological development and coordinate the efforts needed for the exploration and exploitation of space.” Furthermore, it asserts that “to contribute to attaining the objectives referred to [above], a European law or framework law shall establish the necessary measures, which may take the form of a European space programme.” Although the Constitutional Treaty does not include any reference to security space, these passages point to a general boosting of the profile of space technologies in Europe, and to a European promotion of investment in space systems. Both will assist proponents of increased emphasis on the use of space in military space and especially in C4ISR. Elsewhere in the Constitutional Treaty, in Article I-13 (covering areas of shared competence), space is called out as a shared competence between the EU and other European entities: “In the areas of research, technological development and space, the Union shall have competence to carry out actions, in particular to define and implement programmes; however, the exercise of that competence may not result in Member States being prevented from exercising theirs.”

¹³³ *Space: A New Frontier for an Expanding Union: An Action Plan for Implementing the European Space Policy*, European Union White Paper, 11 November 2003.

¹³⁴ General Benoit Bescond, “Galileo: Un Produit Européen de Souveraineté?” *Defense*, no. 105 (May-June 2003): 40-43.

The Lessons of Bosnia, Kosovo, Afghanistan, and Iraq

The four most recent conflicts involving U.S. military forces have significantly contributed to changing Europe's approach to military space. Policymakers and military commanders witnessed, on a daily basis, the considerable advantage the United States drew from space systems, combined with new UAVs and the ability to fuse geospatial data (satellite remote sensing, PNT signals from GPS, and digital maps) with real-time video. This integration of space into the C4ISR network was critical to subsequent European military space policy. Influential military theorists (primarily French) began to press for greater European attention to the development of pan-European security space systems.¹³⁵ These include SATCOM, remote sensing, and military enhancements to Galileo. Europe's major space companies (EADS, British Aerospace, Alcatel, Fiat Avio, Snecma, and Thales) have been supportive of these calls to increased investments in security space.

The Increasing Influence of the EU in Space Affairs

Starting in the late 1990s with the first discussions of Galileo, and accelerating with the development of GMES, the EU, and particularly the EC, have begun to exert increased influence in European civil space affairs, supplementing national space investments by providing funding for research and for the operations of space systems in support of EU programs and policies. The EU has continued to depend on the indigenous space programs of individual member states and on ESA to provide the technological capabilities for EU programs, but it is increasingly using its political and economic muscle to set the overall direction of Europe's space efforts.

At roughly the same time as the Commission's White Paper on space policy, the EC and ESA completed a formal Framework Agreement on Space designed to support: "the coherent

¹³⁵ See, for example, IGA Benoit Hancart, "Le Domaine Spatial dans la Prospective de Défense," *Défense*, no. 105 (May/June 2003): 21-24; Général Daniel Gavoty, "Le PPSM une Politique Spatiale Ambitieuse?" *Défense*, (May/June 2003): 25-28; Gen. Daniel Gavoty, "European Global Space Metasystem for Security and Defense," Presented at the Athens Green Paper Consultation: Security and Defence Aspects of Space: The Challenges for the EU Contribution to the Green Paper Consultation Process, 8 and 9 May 2003. http://europa.eu.int/comm/space/futur/consultation5_en.html.

and progressive development of an overall European Space Policy...and to establish a common basis and appropriate practical arrangements for efficient and mutually beneficial cooperation between ESA and the EU.”¹³⁶ This agreement further underscores the growing EU influence in European space affairs. The agreement provides the framework for potential expansion of Europe’s investment in space.

Using Civilian R&D to Create New Military Capability

In contrast to U.S. practice, Europe depends heavily on civilian and commercial R&D to jumpstart development of related military systems. European militaries have been cautious about spending on dedicated space systems. Until recently, only the United Kingdom and France have developed dedicated MILSATCOM systems. France’s Helios system, an electro-optical system of about one meter resolution, is the only dedicated military reconnaissance satellite deployed by a European country. Both France’s Syracuse COMSATs and its Helios satellite were explicitly preceded through civilian technical development (Syracuse is not yet a dedicated military COMSAT, but provides dedicated transponders on Télécom 2 satellites; Syracuse 3, to be launched by the end of 2004, will be the first dedicated French military COMSAT). The same is true for the United Kingdom’s Skynet and communication satellite systems as well as the Spanish Hispasat and the Italian Sicral systems. Germany, Italy, and Spain are also developing dedicated military COMSATs after earlier investments in dual-use systems.

Helios is based on technology originally developed for the French civilian SPOT series of satellites. The French planned Pleiades (electro-optical) system will provide improved resolution and color discrimination capabilities. It and the Italian Cosmos Skymed SAR earth observation systems will be intentionally dual purpose in nature. Both are elements of a cooperative program between France and Italy. Germany’s SAR-Lupe dedicated military radar satellite is possible in large part because of the substantial investment ESA and the German Aerospace Center have made in basic SAR technology.

¹³⁶ European Space Agency “ESA and the EU: the Start of a New Partnership,” ESA Press Release 76-2003, 12 November 2003. Agreement signed 25 November 2003. Michael A. Taverna, “European Space Pact,” *Aviation Week & Space Technology*, December 1, 2003, 33.

The dual-use approach, starting with a commercial investment, has the advantage of saving defense euros for other air-, ground-, or sea-based military systems. Nevertheless, some systems, such as early warning and electronic surveillance, have no clear-cut civilian counterparts and need to be pursued for their own sake, though they use subsystems and technologies developed under civil budgets. To date, only France has plans to develop both types of systems.

The Long Road to Integrated C4ISR Space Systems

These promising European moves toward a space element in C4ISR capabilities face numerous challenges before an integrated trans-European network will emerge or full interoperability with the United States can be achieved.

Integration with Existing C4ISR Capabilities

One challenge will be integrating space systems into existing air, ground, and sea-based C4ISR capabilities. The U.S. experience suggests this will be a difficult task. The Iraq war made clear that even U.S. systems are not fully integrated, despite years of effort and billions of dollars of investment. However, the less developed European C4ISR capability overall may prove a blessing in disguise, allowing the European to leapfrog some of the legacy problem the United States faces. Europeans may also learn, through interaction with the United States in NATO and coalition operations, how to facilitate that integration task, potentially reducing the time and expenditure for the European integration effort.

EU Expansion and Resource Issues

In May 2004, the EU took in 10 new countries,¹³⁷ an expansion that will likely bring additional complexity to the European military space task. The new countries will likely wish to join the space efforts underway in the more technologically advanced partner countries, which provide an opportunity to participate in space systems development without starting from

¹³⁷ Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, and Slovenia.

scratch. The new partners may bring additional resources, but their relatively weaker economies could slow progress on these programs.

More fundamentally, the EU enlargement is a costly process. Space investments at the trans-European level are likely to compete with other priorities, such as regional and agricultural policies, making it difficult to fulfill the White Paper's call for increased funding for space systems. The political and resource tradeoffs will be difficult, though some of the new members may be attracted to the civilian and dual-use contribution of space assets to their economies.

The ESA Charter and Dual-Use Technologies

The military exploitation of Galileo and GMES will be a telling indicator of the degree to which space assets are going to be integrated into the emerging C4ISR architectures in Europe. European politics may slow their rapid exploitation for military use. For example, ESA's Convention expressly limits ESA participation to peaceful space efforts, though the space programs of the individual countries generally have no such prohibition. Further, security uses of GMES are limited to supporting the Petersberg Tasks.

Despite these limitations, however, significant pressures built within Europe during 2003 to define the term peaceful to match the U.S. definition, meaning technologies that contribute to defensive strategies and that would have supportive roles in warfighting. Reshaping the definition would explicitly allow ESA to take on security-related tasks and to expand the scope of GMES into the gray areas between peacekeeping and peacemaking, allowing closer integration with C4ISR plans. Under the leadership of its director, Jacques Dordin, ESA recently reevaluated its Convention, concluding that it does not restrict the agency's ability to engage in programs aimed at defense and security for national or international security and defense institutions. The agency also established a security clearance system that enables it to handle classified information. ESA's neutral member states also have signaled that they are willing to have the Agency take on a more active space security role for Europe as a whole.

A recent study commissioned by ESA and organized by the Istituto Affari Internazionali (IAI) and a number of other European organizations¹³⁸ summarized the emerging approach to European security space issues:

A new security concept is emerging. The evolution of the foreign, security and defense policy (CFSP, ESDP) and the protection of population require an integrated approach. Security needs are connected to the technological progress. Space assets must be used to protect populations, resources and territories, but also to maintain the integrity and the capabilities of the technological base. Space systems are a fundamental aspect of technological security: they offer extremely versatile solutions in a global, international dimension.¹³⁹

This study recommended that ESA engage in dual-use R&D and suggested that the EU might benefit by setting up a “European Security and Defence Advanced Projects Agency” with a small, nonpermanent staff and flexible, mission-based activity. Like the U.S. Defense Advanced Research Projects Agency (DARPA), this would provide a framework for pursuing a strategic approach to applied technologies of the future, combining a well-defined vision with highly responsive structures and methods.”¹⁴⁰ Just how far Europe will go to emphasize development of dual-use space systems or to create an agency such as this remains to be seen. Nevertheless, the trend toward greater focus on military uses of space is accelerating.

Trans-European Military Space Cooperation

In addition to the civilian and dual-use cooperation already discussed, there are also emerging efforts to coordinate European military space assets directly. Here, as with both civilian space and defense planning in general, France has taken a lead, shifting its strategy from

¹³⁸ The institutes included: *Istituto Affari Internazionali* (IAI), Rome; European Union Institute for Security Studies (EU-ISS), Paris; Centre for European Reform (CER), London; *Deutsche Gesellschaft für Auswärtige Politik* (DGAP), Berlin; *Fondation pour la Recherche Stratégique* (FRS), Paris ; *Institut d’Etudes Européennes* (IEE) of the University of Louvain.

¹³⁹ Stefano Silvestri, rapporteur, “Space and Security Policy in Europe,” *Occasional Papers*, no. 48 (Paris: European Union Institute for Security Studies). (<http://www.iss-eu.org>).

¹⁴⁰ *Ibid.*, 6.

national systems to the promotion of multilateral cooperation at the European level. France has led in organizing Germany, Italy, Spain, Belgium, and Greece in a joint program - *Besoins Opérationnels Communs* (BOC) - to develop common requirements for security-related earth observation. As part of BOC, the participants are developing a federation of data providers and users that will collect and distribute earth observations data among its members. Each member brings different, but largely complementary, capabilities to the table. The BOC is an expansion of cooperative arrangements already underway between France and Italy on Pleiades and Cosmos-Sky Med, and between France and Germany on Pleiades and SAR-Lupe. Linking electro-optical and SAR observations will create a very powerful reconnaissance tool.

This military cooperation has extended to NATO, as well. NATO was under pressure to select a European manufactured COMSAT capability as a replacement for at least some of the current generation of satellites. On 5 May 2004, the Alliance announced that a Joint Consortium of France, Italy, and the United Kingdom will build the new constellation, which will replace the two existing NATO-owned COMSATs and provide NATO with a far greater satellite capacity than currently exists. This will include increased coverage and expanded capacity for communications, including with ships at sea and with NATO's AWACS early warning aircraft.

France and the United Kingdom have previously cooperated on their SATCOM programs. Nevertheless, it remains to be seen whether or not the other main players in European space development, Germany, Italy, Spain, and the United Kingdom, will follow France's efforts toward a truly pan-European space defense. In the 1990s, France sought to interest Germany and Italy in contributing to the development of Helios 2, but those arrangements fell through, in large part as a result of German reluctance to tie itself too tightly to a French initiative.

French planners also attempted during the 1990s to broaden cooperation in MILSATCOM through Trimilsatcom, a system to be developed by the United Kingdom, France, and Germany. This COMSAT was intended to meet the common military needs of the proposed partners. However, the Trimilsatcom effort failed a few years later because the partners were

unable to integrate their requirements into a common program and agree on a schedule for meeting them.¹⁴¹

Cooperation With the United States

The emerging European space-based architecture could provide some promise for enhanced transatlantic interoperability, as well. However, continuing U.S. resistance to greater transatlantic technology transfer is likely to dampen moves toward greater technological cooperation. In response to these concerns, European companies have begun to use fewer U.S. components in space systems because of the difficulties posed by U.S. export controls. The recent agreement between the EC and ESA reportedly calls for a technology development program to assist in insulating EU firms from U.S. technology export rules.¹⁴² At the same time, the agreement also calls for broader cooperation with a variety of countries, including China and India. However, it also calls for closer cooperation with the U.S. Air Force. If, as expected, the United States and Europe forge a workable agreement on the development of Galileo, that experience may assist in achieving closer cooperation between the two entities on PNT-related issues, which could spill over into other forms of space cooperation.

Conclusions

Europe presents a mixed, complex story with respect to military space and the role space technologies might play in creating a European C4ISR capability. On the one hand, a variety of pressures within Europe and outside suggest a much larger role for European security space than could have been envisioned a few years ago. On the other hand, a variety of countervailing pressures will limit the speed with which Europe can transform its current disparate programs into an integrated whole. The trend toward greater use of space assets for network-oriented tasks is unmistakable; the pace at which this capability is achieved may be slow.

¹⁴¹ Laurence Nardon.

¹⁴² Peter de Selding, "ESA Plan Would Widen Cooperation, Insulate Firms from U.S. Rules," *Space News*, December 8, 2003, 3.

Conclusions

The principal conclusion of this study is that there is not a significant technology gap, as such, between the United States and its major European allies when it comes to technologies applicable to the needs of C4ISR. At the level of the basic technological inputs—information technologies, communications equipment, sensing platforms—Europe possesses ample technology, both in the defense and the commercial sector, to compete with U.S. technology. It possesses the know-how needed for cooperation with the inventors and producers of U.S. technology to develop systems and capabilities that can interoperate with U.S. defense technologies, whether these are still being researched or already deployed.

The C4ISR and network centric issues are not principally about technology; the technology exists both in the United States and in Europe. It is also an oversimplification to argue that there is an outright C4ISR capabilities gap between the U.S. and European militaries. There are clearly gaps in capabilities, but they are not at the extreme of arguing that the United States, and only the United States, is moving toward a full, network centric C4ISR capability, while the Europeans are irretrievably mired in the last generation of military technologies.

As this study shows, a number of the European allies already possess or are seriously exploring elements, even the full spectrum, of modern C4ISR capabilities. The major defense powers—especially the United Kingdom and France—experienced the Gulf War and the Kosovo air war as a serious wakeup call with respect to C4ISR and interoperability with the United States. Within available means, these countries, along with the Netherlands and Sweden, have gotten the message and are investing in new, cross-service C2; upgrading communications gear with new radio programs; building in IP capabilities; researching, testing, or deploying UAV platforms with modern sensors; and tackling problems of cross-service interoperability. Especially within the NATO framework, there is major exploration of network centric interoperability with the United States and the potential for even greater progress in the future.

The EU is also beginning to pay attention to such capabilities, under the framework of the ECAP and the emerging EDA.

The common wisdom about the C4ISR technology gap is not a useful foundation for enhancing transatlantic alliance interoperability or increasing joint participation in network centric capabilities. There are important nuances in the transatlantic comparison that deserve focus, if a transatlantic policy is to be shaped.

- The focus on modern C4ISR and networked capabilities is not uniform across Europe. The United Kingdom is probably the most advanced in tackling much of the range of capabilities required, and in doing so in a coordinated way with the United States France invests across the full range of capabilities even more broadly than the United Kingdom (including space sensing, for example) but, as a result of policy considerations on both sides of the Atlantic, is only partially able to tackle the transatlantic dimension of interoperability in C4ISR. Sweden has laid out a plan for reaching a networked C4ISR capability, and appears to be moving slowly forward to achieve it, but interoperability is constrained by national policy and its absence from NATO. The Netherlands is acquiring communications tools that increase its already substantial C4ISR interoperability within NATO. Germany, Italy, and Spain all have declared policies that focus on C4ISR, networked capabilities, and interoperability, but deployed capabilities are still thin and uneven.

- No NATO ally intends to build or deploy the full, global set of networked capabilities projected by the United States. Only France has invested in virtually all of the elements of such a capability, but no nation has the individual resources to build a capability comparable to that of the United States

- There continue to be major interoperability gaps both within and between the European allies. While many are developing or will soon deploy C2 systems that cross service lines, and common communications are the focus of some (the United Kingdom Bowman system is probably the most ambitious and comprehensive), the

results are still uneven across the seven countries studied. Even when the nation interoperability gap has been solved, the trans-European gap remains. Interestingly, few of the countries under study place high priority, as yet, on achieving European-level interoperability. Virtually all are focused on achieving some form of interoperability directly with the United States or indirectly, through NATO. Where intra-European interoperability exists, it is largely in the NATO context, through common programs, STANAG compliance, and combined high-readiness headquarters.

- A substantial share of European national-level investment in C4ISR and networked capabilities is still in the research, technology exploration, and development stage. The investments of the past decade are only beginning to pay off, with deployments happening between the near future and at least 10 years from now. The slow development, caused by limits on resources, is creating a mismatch between European timing and the rapid pace of U.S. research, testing, and deployment. This is the substance of the widening gap focused on publicly. It is not that the Europeans lack the capability; it is that such capabilities are emerging at a far slower and more limited pace than those in the United States

- There are several reasons for this deployment gap. One has to do with European strategic policy. Europe is only slowly defining a common, trans-European policy that would make acquiring this capability a priority. As a common European commitment to out-of-area operations and agile and mobile forces emerges, it will constitute a strong incentive for a redirection of national and trans-European defense investment. A Europe uncertain about its military roles and missions enhances the drag effect of legacy forces and investments at the national defense planning level. This drag effect exists in all the countries under study, and is significant in some of them, particularly Germany and Italy, which have substantial investments in legacy forces and the industry that provides their platforms.

- The other reason, closely tied to the first, involves resources. Given the major nondefense budget commitments of many of the European countries and the unclear definition of defense priorities, it has proven enormously difficult to redirect public resources to defense and, as a consequence, to investments in modern C4ISR and networked capabilities in most of the European allies. The deployment gap comes down, in large part, to a budget gap. It is not so much that the resources devoted to defense are inadequate, as that existing defense budgets are committed to forces and legacy equipment, making a redirection to C4ISR and networked capabilities difficult.

Policy Recommendations

There are clear, persuasive reasons for making C4ISR investment and transatlantic interoperability a high priority. The era of static, large, armored forces, in place to confront and deter the adversary's massed formations, is over. The era of forces that train and exercise together but are rarely used is over as well. The most important reason for Europeans to invest in modern C4ISR capabilities, and for the Europeans, NATO, and the United States to focus on transatlantic C4ISR interoperability, is that smaller and more agile forces are being used in coalition operations—both combat and post-combat—in theaters outside the NATO treaty area.

The United States is unlikely to want to undertake military operations of the Iraq scale without stronger allied participation and even NATO support in the future. And the much-debated question of out-of-area operations for NATO has been answered, with greater European interest and willingness to participate in such operations, as the creation of the NRF indicates.

Coalition operations are a fact of life. Coalition military activity in Bosnia, Kosovo, Afghanistan, and Iraq have made it clear that connectivity between United States and its allied forces is a major obstacle to such operations in the future. As NATO out-of-area and other coalition military operations become more global and at least some Europeans join in, such connectivity will become more and more critical.

Such connectivity will not emerge spontaneously, as a result of a sudden decision to deploy and operate together. The frustrations of creating it ad hoc on the battlefield will lead, as they have in Iraq, to the carving out of separate operating zones for different national forces. True interoperability requires sustained planning and investment on both sides of the Atlantic, a willingness to make the effort needed to wire systems together well in advance of any particular deployment, and artful use of the opportunities available in NATO to achieve this goal.

There are other reasons for making transatlantic interoperability a priority. Technological efficiency is one. On their own, the technologies that are relevant to C4ISR would flow globally,

especially as many of them are drawn from a global, commercial technology market for information and communications. Such a flow would be advantageous to both sides. This study suggests that there are technological capabilities the Europeans bring to the C4ISR world, from which the U.S. military could benefit in such areas as communications and UAVs. There are also clear potential benefits from a flow of U.S. C4ISR technology to Europe.

As these technologies are subject to dual-use and military technology transfer regulations, inefficiencies and redundancies are inevitable. Industries interviewed in the United States and Europe complain that even the European and American business units of the same firm cannot maximize technological synergies because these regulatory regimes get in the way. The result is redundancy—the same or similar technologies being developed separately on both sides of the Atlantic—and conceivably less capability because technological synergies cannot be exploited. The same can be said for technologies inside the European C4ISR market; separate investments lead to expensive and duplicative programs.

There is an economic cost to this inefficiency. A low rate of investment in such technologies, as a result of a smaller national market, means the technology is being purchased at a higher than necessary cost. In addition, there is a budgetary cost. Separate investments in redundant conceptions for the same mission are wasting scarce defense budget resources.

Criticized for relatively low levels of defense spending, many of the European countries in this study recognize that they are paying a budgetary price for this kind of inefficiency. Within the NATO context and even within the cross-European context outside of NATO, there are important efforts underway, in such areas as UAVs and space systems, to define common investments in common capabilities.

The United States is also reaping economic and budgetary inefficiencies by insisting on unilateral investments in C4ISR and resisting transatlantic partnership and collaboration. While industry-led cooperation across the Atlantic can close some of this gap, the U.S. reluctance to buy from Europe and stringent export control and technology transfer restrictions put sharp limits on this natural flow of technological cooperation.

A more flexible transatlantic technology market has potential benefits both for U.S. and European defense investments and, thus, defense budgets. Competition is already increasingly hard to achieve in the U.S. defense market, even with significant increase in defense budgets. It is even more difficult in the European context, where defense budgets, especially R&D budgets, are smaller.

The interoperability, technological, economic, and budgetary gains that could be achieved by greater intra-European and transatlantic collaboration in C4ISR capabilities are not being realized today. The findings of this study suggest a number of policy actions, in Europe, in the United States, and particularly in NATO, which should be considered if these benefits are to be reaped.

European Policies and Actions

European commitments, deployments, and policies in the C4ISR arena are greater than sometimes supposed, but as the above discussion suggests, there is some distance yet to go if the interoperability gap is to be closed. There is not yet a clear cross-European commitment to addressing C4ISR interoperability; it is not clearly central to European defense planning, and it is not embedded in a strong European commitment to joint planning on forces, requirements, and R&T investment. The most significant European commitment to interoperability takes place inside the NATO framework. Moreover, the European defense market is not fully open to the benefits and efficiencies that could be realized by a more flexible movement of technology and greater competition among the suppliers of that technology.

The European allies need to make a clear commitment to the goals of intra-European and transatlantic C4ISR connectivity, both in NATO and in the EU defense planning contexts. This study suggests that, in particular areas, European national governments have recognized the importance of such connectivity.

Most of the nations studied design their C4 systems and equipment to meet NATO STANAGs. In the air (fighter communications) and at sea (naval communications and, increasingly, fire control and targeting) the interoperability challenge is being met and a fair degree of connectivity has resulted. Our research suggests that such connectivity is lacking with respect to land forces, sometimes within national militaries as well as at the trans-European and NATO levels. All nations are working on this problem, as the Bowman program in the United Kingdom exemplifies.

The problem the Europeans face is that conforming to NATO STANAGs will not, alone, solve the interoperability problem. The pace of U.S. C4ISR innovation goes well beyond NATO STANAGs. At the same time, the NATO context is the most promising place to address this issue systematically. European governments need to move more quickly in the NATO STANAG framework and need to urge that the system broaden its coverage to also include surveillance and reconnaissance system standards.

The second major framework for addressing this issue is NATO's new ACT. It will be important for the European allies to engage as fully as possible in the work of ACT, which has the potential to be a critical context for the transatlantic dialogue on C4ISR and networked operations.

A similar commitment needs to be made at the EU level, in the framework of the Headline Goal and ECAP processes. As suggested in our research, while C4ISR interoperability issues are on the table in the EU policy process, they do not appear to have received priority attention.

A European commitment to C4ISR interoperability as a priority needs to be set in the framework of European strategic planning. The requirements to be met for interoperability will be driven by a careful look at the missions the Europeans plan to undertake and the capabilities needed to network the C2, communications, and information need for those missions. This explicitly does not mean that the Europeans need to adopt U.S. global missions and goals to be interoperable in the C4ISR domain.

The critique of European investments commonly heard in the United States tends to grow out of a projection that European military roles, missions, and forces need to look like those of the United States to be interoperable or useful in coalition operations. However, even at the cross-European level, the allies do not need to build or deploy the global grid the United States is creating for NCW. The Europeans are unlikely to undertake large, global operations at a global level, and hence are unlikely to invest in building the resources to do so. Given the differences in strategic ambition, there is probably no requirement for the Europeans to do so. Hence, the European investment in C4ISR is not likely to look like that of the United States in scale or capability. The United Kingdom move toward NEC suggests the difference in scale and approach: developing network enabled capabilities by testing and modifying existing equipment and evaluating new systems against this network requirement, rather than building an entire network centric architecture from the ground up—evolution, as opposed to revolution.

The policy question involves how to ensure connectivity where the European and U.S. force capabilities must meet—in coalition deployments inside or outside the NATO framework, or the missions given to the NRF outside the NATO area. Given the strategic and resource gap, then, it is critical for the Europeans, in cooperation with the United States, and in the NATO context, to define the critical nodes in the U.S. C4ISR system into which European capabilities need to plug in order to play.

A plug-and-play strategy makes sense for Europe. The model would be for the United States or NATO, or both, to provide the backbone for a network and for the Europeans to select the points in the grid which are critical to ensure the needed interoperability. Interoperability will be centrally about the transmission, in a timely way, of voice, data and images—the information that enables networked operations. The plug-and-play strategy will rely on common software standards and capabilities. Ensuring that software standards are shared, commonly deployed, and secure will facilitate the communication of voice, data, and imagery among larger (U.S.) and smaller (European) networks. The Europeans will not need all the satellites the United States possesses to benefit from the intelligence those satellites deliver, nor all the UAVs, but their systems will need to be capable of receiving and disseminating appropriate data.

The Europeans can then decide on the extent to which they require their own independent capabilities if they wish to operate autonomously from the United States or from NATO assets available through the Berlin Plus arrangements. European ambitions can be tailored to European requirements and European resources, but interoperability in the Alliance will be reinforced.

The NRF can provide a particularly useful context and test bed for addressing this C4ISR interoperability issue. The United States sees the NRF as a European force, reflecting European commitments. While the United States will be providing logistical and C4 support to the force initially, the expectation is that the Europeans will eventually provide all these capabilities on their own. The United States will see the NRF as a litmus test for European willingness to develop integral C4ISR that can interoperate with U.S. forces. Given the need to stand up NRF by 2006, the European allies should focus on meeting NRF C4ISR requirements as a near-term demonstrator for C4ISR capabilities that will have applications to European capabilities down the road.

Both inside and outside the NATO context, the Europeans also need to develop a common view on trans-European interoperability. British MOD officials, for example, are focused on C4ISR interoperability directly with the United States, but spend less time focusing on interoperability inside NATO or with their continental European allies. French defense officials give attention to internal interoperability among their forces, but little or no thought to joint architectures for C2 or interoperable equipment with Britain or Germany. Where interoperability exists—in the air and at sea—it results largely from NATO requirements and the acquisition of U.S. systems, not from addressing interoperability at the European level.

Part of this challenge stems from the absence of cross-European interaction at the level of force and requirement planning within defense ministries. The Headline Goal and ECAP processes, important as they are, do not constitute such joint force and requirements planning. They focus on a particular set of forces and capabilities, not on overall defense activity. There is a noticeable gap between the rhetoric and discussions at the Brussels level, and the nitty-gritty of

day-to-day planning and procurements at the national level. National defense planning processes are not coordinated and the focus in defense ministries is still on national capabilities.

As long as these processes are largely carried out at the national level, spending for interoperability and C4ISR will compete with legacy systems and the deployment gap is likely to grow. Some resources could be realized by reducing legacy forces and systems at the national level, but these are unlikely to be adequate.

This problem of inadequate coordination is particularly obvious when one examines the resources directly related to C4ISR technologies: funds and programs in R&T. Our study shows a pattern of R&T spending where overall resources are low and redundant between countries. Moreover, because resources are stretched and procurement funds are limited, once a technology has reached the prototype or demonstrator stage, moving into production is difficult.

Coordination across borders on R&T is not common. While the French and British devote significant sums to defense R&T, they engage in very little coordination of those programs. Germany has recently set a goal of developing more networked forces, with a focus on C4ISR, but coordinates little of that effort with its partners. Indeed, some significant restructuring of the German defense budget, and a further reduction of significant land forces, could well free up the euros needed for that more networked capability. The hidden secret of European defense resource planning, especially in exploring C4ISR technologies, may be less in the need for more euros, and significantly more in the elimination of redundancies, continuing reprioritization of existing resources, and significantly higher levels of coordination on R&T across borders.

A truly trans-European defense planning system is the only ultimate solution to this problem, but it is a long way off. The European Defense Agency, due in mid-2004, is a step in this direction, but only a small one. Meeting C4ISR requirements in an affordable way will depend on such a system being in place, covering force planning, requirements and R&T investment. Only at that level can redundancies be eliminated and forces trimmed in a way that will release budgetary resources to do the research and procurement needed to meet the

interoperability requirement. As long as force and requirements planning and R&T programming are concentrated at the national level, resources will be stretched and the target hard to meet.

Linked to the need for an interoperability focus, attention to the trans-European level of planning, and the greater integration of national planning capabilities, it will also be important to the creation of a cross-European market for dual-use and defense technology. Europe does not yet fully exploit the advantages of the large-scale consolidation and gradual privatization of defense industry and technology capabilities that has taken place over the past decade. European policy is slowly moving in this direction, as this study suggests, but policies and institutions are far behind the evolution that has taken place in the industry itself.

Despite industry consolidation, national defense industry policies vary widely, bureaucratic requirements for investment in research and acquisition differ, and there are few incentives to industry to collaborate actively and openly, or to compete transnationally, in the C4ISR or other defense arenas. The European defense industry and technology sector is increasingly transnational, but it responds to government requirements that have been defined largely on a national basis. In addition, the market conditions have not yet been created which make it easy to move military technology easily across frontiers and compete in each others' markets.

This problem stems, in part, from the fact that national research and procurement institutions are a reflection of the national orientation of overall defense planning described above. It also reflects an understandable political response to the economic consequences of nationally based procurement systems; local employment can trump defense efficiency and the value of cross-European market policies.

While slow progress is being made toward the creation of a European defense market (LOI, OCCAR, the EDA, EC research programs), governments could go considerably further and faster than they have to date to create a more open, competitive, intra-European market for defense technology and equipment. The European playing field is far from level, and national views differ substantially. While there are common European defense programs (largely

platforms such as the A400, Tiger helicopter or fighters), they tend not to be in the C4ISR arena. National technology assets and producers tend to be favored in the C4ISR arena, reinforcing the problems of interoperability among European countries. International competition and collaboration is not encouraged in most of the major countries.

The United Kingdom technology and defense market is beginning to change, as a matter of conscious policy, setting a model that other European countries may want to explore. United Kingdom defense procurement policy has moved sharply away from the model of a protected national monopoly, and toward the encouragement of transnational competition and teaming. Following industry consolidation, BAE Systems held a dominant position in the United Kingdom defense market. However, the MOD has clearly signaled that the British market is open to transatlantic and international competitors, which has led to a growing presence in the United Kingdom defense market, and especially the C4ISR part of that market, for such firms as Thales, Raytheon, EDS, and General Dynamics, among others. The purpose of this change was to reap the advantages of competition and international teaming and to ensure that the broadest array of technology was available for British defense needs. In return, non-United Kingdom firms are expected to bring a substantial portion of work share into the United Kingdom, strengthening and broadening the domestic defense technology industry at the same time.

The British model may provide useful lessons for market policy at the European level. It will not be easy to overcome the weight of the European defense industrial legacy, but the model promises advantages of competition, efficiency, and budgetary savings that could have important payoffs for European and transatlantic interoperability.

For transatlantic interoperability to occur, it will be equally important that the European market be open in the framework of the NATO alliance, as well. Europeans should be cautious about the degree to which the LOI, OCCAR, EDA, and EC research processes move in a direction that closes off what has been a remarkably open market, compared to that of the United States (see below). Policies that restrict access to the European market will deprive the Europeans of the advantages of competition and of access to technology that would provide greater interoperability.

American Actions

This study did not examine U.S. C4ISR capabilities or policies, which would be needed for a full understanding of the interoperability problem. Nonetheless, it seems clear that European C4ISR technological capabilities are comparable to U.S. technologies and potentially interoperable. The future of coalition interoperability and the potential gains in economic and budgetary efficiency will depend in part, however, on U.S. capabilities and actions. Therefore, we offer some recommendations for U.S. policies, as well, which will be needed to facilitate the transatlantic interaction needed to achieve the goal of interoperability.

U.S. policy needs to focus on three dimensions of the transatlantic defense trade problem: an understanding on strategic perspectives, taking European C4ISR technology and interoperability capabilities and intentions seriously and working in the NATO context to enhance the opportunities for greater connectivity, and transforming the U.S. regime for transatlantic defense trade to accommodate interoperability requirements, transatlantic technology collaboration, and industry efficiency.

The transatlantic strategic discussion was dramatically restructured by the end of the Cold War. With the disappearance of the Soviet Union, the transatlantic relationship needed to be reshaped. Some of this reshaping has been achieved intentionally—the enlargement of NATO to include members of more limited military capability but badly in need of reassurance that they belonged to the West was the most important intentional change.

Some adaptation has been unplanned, but even more significant. The extension of NATO's mission to restore order to the Balkans was a major change for the alliance, and its first involvement in actual combat in the wider European theater. The Balkans operations also created stresses in the alliance, which has played a role in leading the United States to opt for coalitions of the willing and clear U.S. leadership in coalition military operations in Afghanistan and Iraq.

These two most recent wars are likely to be representative of future military operations in the 21st century—expeditionary forces deployed at some distance from the homeland, operating in relatively spare environments, moving with agility and focus to strike adversary targets effectively and terminate combat operations quickly. With reference to the subject of this study, these 21st century wars will rely more than ever on networked operations, integrating sensors data, communications, and the measurement of effects.

Combat in Iraq has had a divisive effect on Alliance relationships. The disagreements between the United States and France and Germany have had one kind of impact on transatlantic efforts to achieve greater interoperability in the alliance. It has given some Europeans an incentive to accelerate efforts to create a more autonomous European military capability to respond to a different European view of strategic requirements. It also appears to give some U.S. policymakers an incentive to withdraw further from working strategic issues in the NATO context, and to assume that Europe will not acquire an interoperable capability of use in future coalition operations.

Here too, NATO offers an important framework for overcoming such tensions. The NATO Prague summit of November 2002 made significant progress with respect to strategic dialogue and the transformation of Alliance forces for the new missions and technologies of the 21st century: reshaping the NATO command structure with a new transformation command, setting new capabilities objectives, and endorsing the NRF.

The U.S. government has the initiative, today, to move the transatlantic system toward strategic understanding and coalition interoperability, and NATO can be the setting to accomplish this goal. A new strategic dialogue in NATO urgently needs to be undertaken.

A resolution of the first issue will be directly linked to the second: taking European technological and military capabilities seriously. Our interviews suggest a fairly common disdain among U.S. policymakers for these capabilities and skepticism that the Europeans intend to address them seriously. The lesson some policymakers have drawn from the past five decades, and the last one in particular, is that European forces are generally heavy on manpower and

equipment; light on new, network centric planning and procurement; and, overall, inadequately adjusted to post-Cold War realities. In particular, Gulf War I and the Kosovo air war indicated, in this view, that European land forces lacked the real-time information and C4ISR capabilities necessary for agile expeditionary operations, and their air forces could not ensure secure real-time interoperability for air interdiction missions.

As a result, U.S. military planners have made little effort to involve the Europeans in U.S. planning for network centric capabilities or to include European technologies in the process of developing these capabilities. The frequently expressed attitude was to argue that the Europeans could close the technology and capabilities gap simply by buying U.S. equipment. European efforts to shape autonomous capabilities, such as the A400M or Galileo navigation satellites, are disparaged as a waste of funds, when U.S. capabilities could be relied on or purchased.

This general disdain of European capabilities has been combined with a “not invented here” view prevalent in the Defense Department. In this view, it is easier to work within known processes and with known U.S. suppliers; extending the DOD process to include European suppliers and military planners is a step into the unknown. U.S. suppliers, moreover, are comfortable in their relationship with the Defense Department and reluctant to bring European firms into the U.S. market as potential competitors.

If the transatlantic interoperability problem is to be overcome, this prevailing attitude will need to be addressed, as the alternative requires sustained interaction with the Europeans, bringing them into U.S. plans and requirements processes. NATO provides perhaps the most important context for this multilateral dialogue.

Strategic dialogue and joint planning will only go part way toward solving the C4ISR interoperability problem. U.S. export control and technology transfer policies constitute a third, major obstacle to any effort to expand transatlantic technology cooperation.¹⁴³ Policy and industry analysts have noted for some years that the U.S. National Disclosure Process (NDP),

¹⁴³ Center for Strategic and International Studies, *Technology and Security in the Twenty-first Century: U.S. Military Export Control Reform* (Washington, DC: CSIS, May 2001).

International Traffic in Arms Regulations (ITAR), Committee on Foreign Investment in the United States (CFIUS), and Special Security Arrangements (SSA), all of which regulate the transfer and export of U.S. defense technologies and the process of direct foreign investment in the U.S. market, pose major challenges to the technology transfers that will be needed to close the interoperability gap between the United States and its European allies.¹⁴⁴

Transfers of defense technologies to allies must go through intensive scrutiny in the Defense Department and an interagency discussion, before they are allowed to take place. Frequently, this process leads to a decision to share parts of hardware with allied collaborators, but not things such as software codes that govern the operation of the system, leaving allies in possession of only part of the information they would need to operate, repair, overhaul, or adapt systems purchased from or built in collaboration with the United States. The U.S.-German-Italian MEADS battlefield ballistic missile defense system, for example, has faced this black box problem for years.

U.S. export control rules compound the problem. All military technology exports or overseas transfers, including the exchange of oral or written expertise, require a license from the Office of Defense Trade Controls in the State Department, after interagency coordination (including the Defense Department and the services). The slowness and complexity of the U.S. export control process, and the large number of items on the Munitions List, make transatlantic collaboration even more difficult. U.S. firms wishing to collaborate with Europeans encounter delays in this process. European firms seeking to acquire U.S. components for European systems find the system unpredictable, and are increasingly incentivized to turn to European technological solutions. European defense firms with major U.S. operations find that the two parts of the company cannot exploit useful technology synergies across the Atlantic due to the constant need for licenses for such conversations to take place at all.

¹⁴⁴ Gordon Adams, "Fortress America in a Changing Transatlantic Defence Market" in Burkhard Schmitt, ed., *Between Cooperation and Competition: The Transatlantic Defence Market*, Chaillot Paper No.44, (Paris: Institute for Security Studies of the European Union, January 2001).

Finally, the U.S. foreign direct investment and security arrangement issues further complicate the dialogues needed to address the interoperability issue. Direct investments and joint ventures by Europeans (and others) in the U.S. defense market are subject to intensive scrutiny, through the CFIUS interagency process. While very few such investments have been rejected, many are withdrawn, or not attempted, given the complexities and uncertainties in the U.S. process. Successful investments and collaborations, such as the BAE Systems acquisition of Lockheed Martin's electronic warfare assets in 2000 and the creation of Thales Raytheon Systems (an air defense joint venture) take years to execute and are difficult to operate efficiently.

These difficulties are compounded by the complexities of the SSA process. Our interviews for this study suggest that SSA requirements effectively divide the work and workforce of American business units from the European parent company. The requirements are designed and enforced to prevent the flow of sensitive technologies across the Atlantic. They also make efficient cross-corporate collaboration and economic efficiencies nearly impossible.

Even with the best of intentions for strategic dialogue and a genuine willingness to collaborate at the planning level, major reform of the U.S. technology transfer, export control, and investment rules would be needed for the C4ISR interoperability problem to be addressed successfully. Problems in all three areas have had a corrosive effect on the ability of the United States and the Europeans to achieve the interoperability coalition forces require for effective expeditionary operations. C4ISR interoperability is at the very heart of such a capability, and the U.S. rules of the road are a disincentive to achieving that goal.

With respect to strategic dialogue, some progress has been made in recent months, particularly with the clear commitment of the NATO alliance to out-of-area operations, the standing up of the NRF, the European effort to define an EU level view of Europe's strategic concept, and the emergence of new institutional developments in the security arena at the EU. This progress could be further strengthened by an active U.S. commitment to a sustained strategic dialogue with its European allies, as the European process moves forward.

Mistrust and disdain with regard to European capabilities and intentions are equally difficult to change, buried as such attitudes are deeply within the policy and bureaucratic structures of the U.S. government. Two such views, frequently mentioned in our interview process, deserve some discussion.

The first involves the frequently expressed U.S. view that the Europeans must spend more on defense for the gap to close. Clearly more defense euros, properly invested in the right priorities, would contribute to solving the interoperability dilemma. However, for a variety of reasons, most European allies are unlikely to spend more on defense. Arguing that they should is self-defeating and counterproductive.

It is more useful for the United States to emphasize, instead, that existing defense investments in Europe be restructured and focused on commonly agreed strategic and military objectives, rather than demanding higher levels of overall spending. While Germany, for example, may not be willing or politically able to increase its defense budget, this study suggests that the focus of the German defense program is sharply shifting toward expeditionary capabilities incorporating modern C4ISR capabilities. Encouraging this move could help the Germans make the internal budget decisions needed to refocus on the new priorities.

The second self-defeating argument is that that the Europeans should not acquire systems the United States views as wasteful—the A400M and Galileo, for example. The frequent expression of this U.S. view has had the opposite effect—both programs are moving ahead, stimulated, in part, by the criticism. Both are clearly intended by the Europeans to meet European defense (and civil) needs and, in the case of A400M, to acquire a capability—air transport—which the Europeans have long been criticized for not having and which could be very useful in coalition and NATO operations. If the goal is expeditionary operations, separately or in NATO, modern airlift is clearly a requirement.

Buy American, which is the DOD (and U.S. industry) response, is not an answer. The Defense Department would no more buy European at the cost of domestic producers than the Europeans would do the same in the U.S. market. To make a virtue of this political-economic

reality, it may make more sense to explore the opportunities to combine technologies and industrial capabilities through collaboration.

Finally, with respect to the rules on technology transfer, export controls and direct investments, a policy solution may require the United States to recognize that these are viewed asymmetrically between the United States and Europe. In Washington, DC and Europe, these issues are seen as technical, to be worked out by discussions at the technical level—inside the U.S. system and with the Europeans, if needed. For Europe, the rules of the road on exports and investments are seen as strategic, bearing directly on the quality of the security relationship across the Atlantic. Progress in advancing C4ISR interoperability could be achieved with the relative simple step of giving high-level attention to the rules of the road, as a strategic issue, in Washington, DC.

Overall, the problem of interoperability in the area of C4ISR will be critical to the long-term future of the transatlantic relationship and the NATO alliance. Both the Europeans and the United States will be required to take major steps to advance the objective of coalition interoperability along this critical dimension. Our study suggests that the technology is well in hand to resolve the problems at the technical level. The obstacles are political and budgetary, not technological, and they require actions of political will and resource planning on both sides of the Atlantic.

Appendix I: C4ISR in European Defense Industries

This study was not intended as a comprehensive survey of the European defense industry with respect to its technological capabilities for C4ISR. However, discussions were held with a number of defense firms in Europe, who provided, in some detail, a view of their competences in this field. Since significant technical skill resides in the industry, with potential application to C4ISR requirements, this appendix provides a brief overview on industry views and capabilities.

The appendix is broken down into short descriptions of lead companies and their products—both existing and under development—in the C2, communications, and ISR areas. Where relevant, key programs that the company is active in have been mentioned, and its major collaboration efforts with other firms in Europe and in the United States in the C4ISR domain have been reported. While much of the European defense industry base is still national in character, some consolidation of the European defense industry in the late 1990s has resulted in several multinational entities, the largest of which are Thales, EADS, and BAE Systems, that can no longer be affiliated with one particular country. It is in these companies that a significant share of the European C4ISR expertise resides today, and they are therefore described first, and in greater length, in this appendix.

The European defense industry has proven its ability to undertake not only projects at national level, but also multinational (including transatlantic) defense R&D projects. The aforementioned multinational companies such as Thales, EADS, and BAE Systems, with their subsidiaries and sister companies all over the world, can become bottom-up pushers of collaboratively developed technologies, sending ideas and demonstrators to a large number of countries from their local offices. Smaller, more local companies can complement the larger ones with niche expertise and experience from national programs. Such ideas, developed jointly in various countries (but with only a few partners from a few countries, to avoid complicating project management and coordination) and driven by multinational companies, can be demonstrated to individual nations to obtain funding to turn them into large-scale production and acquisition projects. The funding for these demonstrators could be shared by the participating

companies, with possible contributions by EU bodies (e.g. WEAG's EUROFINDER program or the EC's Framework Program). Examples of existing collaborations such as these are the Active Phased Array Radar (APAR) project, codeveloped by Thales, EADS, and Raytheon and deployed by the German, Dutch and Canadian navies (the system enables the tracking and controlling of missiles fired from various sources by a single ship); MIDS (which enables interoperability between United States, British, German, Italian, French, and Spanish ships, aircraft, and missiles); and the Raytheon-Thales proxy, Thales-Raytheon Systems-TRS (working on C2 systems for air defense and tactical communications for Special Forces). Future programs may include a project on JTRSs that can create interoperability nodes between major systems such as RITA, PR4G, MIDS, and various SATCOM systems.

Thales

Thales is one of the world's largest defense and consumer electronics corporations and a European leader in the C4ISR market. In addition to being a lead contractor for many French C4ISR programs, it has been successful in many other countries. In the United Arab Emirates, the company has deployed a complete C4ISR system integrating U.S.- and French-made legacy systems. In other countries, it has provided individual elements of C4ISR suites. In the last three years, largely through the acquisition of British companies with expertise in ISR (such as Racal, Quintec, and Pilkington), Thales has further increased its capabilities in this domain and positioned itself to participate in several key United Kingdom programs.

Thales is in the process of creating a new division, Land and Joint Systems, which will fuse its optronics and its communications businesses as part of a strategic push toward better addressing the C4ISR market. This division offers a wide variety of communications products. These include the family of PR4G radios (sold in 25 countries around the world, including Spain, the Netherlands, Denmark, Greece, Switzerland, Poland, and Egypt) and the RITA 2000 system (based on ATM/IP architecture and deployed by the French and Belgian armed forces). The PR4G version currently under development, the VS4-IP, will have IP, frequency-hopping encryption, a built-in GPS, and advanced multiplexing features. The next generation of PR4G radios will include software radio products.

Thales currently has a strong presence in the C2 market. Products include the Cooperative Fighting System (a tactical C2 system), the LCC mobile C2 network, and the e-CIS army-level C2 system (designed according to NATO STANAGs). Some of these technologies have been integrated into the Martha and Atlas systems deployed by the French armed forces. Future developments include the RITA Local Area System for strategic C2. In naval systems, the company has made great investments in the creation of network centric solutions that integrate existing systems among each other and with new ones.

In the area of surveillance and reconnaissance technologies, Thales expertise includes various types of ground-based systems for surveillance, target acquisition, and ground-based air defense. A product recently developed and produced is SQUIRE, a man-portable surveillance radar system for ground surveillance and bomb damage assessment recently deployed by the Dutch army and marines. Through its Netherlands branch, the company is also a global supplier of a wide range of equipment for naval surveillance systems, weapon control systems, and combat management systems. Key products include the TAVITAC naval combat management system deployed on the French Lafayette frigates as well as in Belgium, Saudi Arabia and Kuwait, and the APAR weapons control system, codeveloped with EADS and Raytheon and deployed on Canadian, Dutch, and German frigates.

Additionally, Thales offers a relatively large variety of products and projects in the intelligence technologies market. It currently plays a key part in several programs around the world, including the U.S. Prophet program for vehicle-mounted SIGINT systems and the future British terrestrial SIGINT system, Soothsayer. In France, Thales is the supplier of the SGEA, SARIGUE, MINREM, and SAIM systems as well as of various airborne ISR pods to various services of the armed forces.

European Aeronautic Defence and Space Company

Created in 2000 through the merger of DaimlerChrysler Aerospace (Germany), Aerospatiale Matra (France), and CASA (Spain), EADS has managed to gain a strong market presence in C4ISR technologies and become a lead prime contractor in many European countries (most notably in France and Germany). One area in which it has been particularly successful–

largely due to a series of collaborative R&D programs—is that of UAVs. These include the sensor package for a strategic UAV (under the EuroHawk, undertaken jointly with Northrop Grumman), the development of tactical- and operations-level UAVs (the Hunter, Eagle-1, and Eagle-2, developed jointly with Israeli Aircraft Industries), the production of several tactical UAVs (CL-289, Brevel, and Luna X-2000), collaboration on the Pointer hand-launched tactical UAV (developed with Aerovironment), and work on a maritime rotor wing reconnaissance UAV (dubbed SEAMOS and terminated in early 2002 when the main potential customer, the German navy, terminated the funding for the project). In 2002, the company had also announced that it intended to launch a program for the development of a UCAV.¹⁴⁵ More recently, in June 2004, the company announced it would team with France’s Dassault Aviation on two new projects: a MALE UAV (dubbed EuroMALE), and an armed combat UAV (dubbed Neuron). EADS will be the prime contractor for the former, and Dassault for the latter.¹⁴⁶

EADS also possesses strong capabilities in the C2 and in the sensor technologies fields. In the former, the company is working on the HEROS, FAUST, and FūInfoSys H systems for the German army as well as on various systems for other customers (which include the Belgian army and several Gulf states). In sensor technologies, EADS is now finalizing the development (with Rheinmetall Defence Electronics) of the ISR platform that will be carried by the Fennek reconnaissance vehicle, to be deployed by the German and Dutch armed forces by 2004, as well as the APAR weapons control system (with Thales and Raytheon) deployed on Canadian, Dutch, and German frigates. It is also supplying its maritime sensor platform, Fully Integrated Tactical System (FITS), to Mexico, Brazil, the United Arab Emirates, Spain, and the U.S. Coast Guard. The company also offers a combined system of SAR and MTIs that can be placed on UAVs, marine reconnaissance NH-90 helicopters, and the proposed SOSTAR-X AGS solution for NATO.

EADS also offers products for the analysis of images captured by various platforms, including satellite imagery, through its OCAPI and TIPI3D products. Additionally, a mobile satellite ground station, called Eagle Vision, has been developed for the collection of imagery

¹⁴⁵ A. James, “Closing the NATO Capabilities Gap: Challenges for the European Defense Industry,” in Nelson and Purcell, *Transforming NATO Forces*.

¹⁴⁶ Pierre Tran, “France Launches UAV Challenge.” *Defense News*, 21 June 2004.

from SPOT, LANDSAT, IRS, RADARSAT, and QUICKBIRD satellites. Four such stations are operational in the U.S. armed forces, and at least one in the French. EADS is also a lead partner in the German GAST project for the development of a common system for the dissemination of technical intelligence.

BAE Systems

BAE Systems was created in 1999 when British Aerospace merged with Marconi Electronic Systems. Today, the company is one of the world's largest in the aerospace and defense sectors, with prime contractor capabilities in naval platforms, aircraft, and electronics. It has also been successful in various sectors of the C4ISR range, with much system engineering and integration experience. Its accessibility to the U.S. market and its central role in supplying the British and Australian armed forces have helped it become a global defense leader. BAE has been attempting to position itself as a defense industry player capable of supplying complete system-of-systems solutions. The firm was chosen by the British MOD to lead the NITeworks partnership aimed at assessing and demonstrating of the benefits of NEC and the options for its effective and timely delivery. In December 2003, it was announced that BAE would provide the Kuwaiti armed forces with a complete C4I suite.¹⁴⁷ These two programs confirm BAE's capability for expertise in NCW and in providing a full set of C4I requirements of a country's armed forces.

One area of expertise in the C4ISR market is in tactical communications systems, partly due to its heavy involvement in, and often leadership of, British programs such as Ptarmigan and Falcon, and its line of Multi-Role Switch (MRS) 2000 equipment. It has also benefited from participation in some U.S. communications programs, most notably JTRS and the Future Combat Systems vehicles' communications package. BAE also provides the British armed forces with their satellite terminals: the Talon (man-portable) and Dagger (vehicle-mounted) terminals linked to Skynet 4 satellites.

BAE possesses very limited capabilities in the UAV sector, largely due to experience with two products (the Phoenix and SkyEye tactical UAVs); however, both of these proved to be

¹⁴⁷ This program is still awaiting approval by the Kuwaiti parliament.

unreliable in various operational environments, and are not considered to be competitive in the UAV market. In UUVs, it is—together with QinetiQ—one of the few large European defense companies to possess expertise in this field through work on the Marlin project. Other ISR capabilities exist mainly through the company's involvement in AMS and Atlas Elektronik (the naval systems portion of STN-Atlas Elektronik retained by BAE when it split the company with Rheinmetall), which give it a dominant position in radar and sensor technology. Involvement in the ASTOR program and the Nimrod upgrades has also been valuable for the company.

BAE's SIGINT unit was sold off in 2002, and few intelligence activities currently remain within the company. It also does not possess any substantial expertise in space technologies.

In July 2003, BAE and Finmeccanica signed a deal to collaborate on C4ISR technologies under a new defense electronic partnership called Eurosystems. As part of this partnership, three new joint ventures will be created. The first will be a systems integration and C4ISR business, majority owned and managed by BAE, with capabilities in C4ISR information systems and subsystems. This company will be formed from existing activities of AMS (a 50-50 joint venture of BAE and Finmeccanica) and BAE C4ISR (without its communications division). The second new company will be a communications systems business, majority owned and managed by Finmeccanica, with capabilities in strategic and tactical communication systems, networks, and secure systems. The business will be formed from the existing activities of Marconi Selenia Communications and the communications activities of BAE C4ISR. The third new company will be an avionics business, majority owned and managed by Finmeccanica, with capabilities in sensor systems, airborne radars, mission systems, electro-optics, and electronic warfare systems. The business will be formed from activities within BAE Avionics and Finmeccanica's Galileo Avionica.

Rheinmetall Defence Electronics (Germany)

In the summer of 2003, BAE Systems and the German firm Rheinmetall Detec, who jointly owned STN-Atlas Elektronik, decided to divide the firm into two separate companies. The new companies are Rheinmetall Defence Electronics, wholly owned by Rheinmetall Detec

and specializing in technologies for air and land forces, and Atlas Elektronik, wholly owned by BAE Systems and specializing in maritime technologies.

Rheinmetall Defence Electronics today is one of Europe's leading developers of ISR solutions. In land systems, it is collaborating with EADS on the development of the ISR suite for the Fennek reconnaissance vehicle ordered by the German and Dutch armies; this will involve the development of a sensor platform that includes a camera, a thermal imager and a laser rangefinder. However, it is in unmanned aerial systems that the company has the greatest potential, especially if it is able to gain a foothold in markets other than the German one. The company currently offers a wide range of reconnaissance, target acquisition, electronic warfare and combat UAVs. These include the KZO/Brevel target acquisition UAV (also configurable for electronic warfare missions), now codeveloped with EADS. It is also working on the Taifun combat drone for unmanned air strikes; however, this project has suffered major delays and is grossly over budget, and following pressure from its funder—the German Defense Ministry—it may eventually be transformed into an ISR vehicle carrying various sensors.¹⁴⁸

In 2003, the company signed an MoU with France's Sagem to develop the technologies for making the KZO and Taifun UAVs interoperable with the French Sperwer.

The company also possesses strong capabilities in tactical C2 technologies for land forces. It has participated in the GeFüSys C2 program for the German army (currently upgraded to FAUST), and provided the Swedish army with the C2 system deployed on its tanks and combat vehicles. In 2003, it was awarded a contract for the upgrading of the C2 systems mounted on Spain's Leopard-2 tanks.

Rohde & Schwarz (Germany)

Rohde & Schwarz is currently a European leader in the military communications field, specifically in digitally reprogrammable software radios. Its family of multimode, multirole, multiband (M3) radios offers solutions for aerial, naval, and land platforms, all meeting NATO encryption STANAGs. Early in 2003, the company was awarded a contract to supply the

¹⁴⁸ Martin Agüera, "Relieve for Germany's Taifun UCAV?" *Defense News*, 7 July 2003, 7.

Brazilian army with the tactical radio version of the M3; however, no contracts have yet been awarded by any European country.

The company is also a major player in the SIGINT field, specifically in technologies for direction finding and signals monitoring and analysis. European customers for these products have in the past included the German and Danish militaries.

QinetiQ (United Kingdom)

Until 2001, QinetiQ was part of the British Defence Evaluation and Research Agency (DERA) under the MOD. That year, the British government decided to create a public-private partnership and transfer the majority of DERA's activities to this partnership. Today, QinetiQ draws upon experience gained as a government R&D agency to provide advanced defense solutions, including some in the C4ISR domain.

In the C2 field, QinetiQ specializes mainly in maritime C2, and currently offers two major systems in this field: the Intelligent Advisor Capability Demonstrator (IACD) and the All Environment Real-Time Interoperability Simulator (AERIS). The former has been demonstrated on the Royal Navy aircraft carrier *Illustrious*.

In the ISR area, QinetiQ undertakes work on battlespace digitization, on fusing information from various sources, and on defining innovative ISR architectures. It also possesses expertise in space-based reconnaissance, having participated in the British TOPSAT program as well as in other international efforts.

In the unmanned vehicles field, QinetiQ current focus is on man-portable UAVs intended for infantry sections. It is also one of the few large European defense companies to possess expertise in the field of UUVs, having worked for the British MOD on the development of the Marlin UUV (intended for launch and recovery from submarines). Additionally, the company has several projects for the development of new sensor suites for UAV's, particularly for thermal imaging.

Sagem (France)

Sagem has been an active European contender in one field of the European C4ISR market, UAVs, and has been extremely successful. Its line of tactical UAVs is deployed by the armed forces of many European countries. The Crecerelle is used by the French army, and variants of it are deployed by the Dutch (where it is known as Sperwer), Danish (known as Taarnfalk), Swedish (known as Ugglan), and, most recently, the Greek armies. Currently, two new versions of the Sperwer are under development, both of which will be capable of flying at higher altitudes, faster speeds and for longer periods of time. The first is the Sperwer HV (High Velocity), a MALE UAV featuring a real-time data link, SAR, day-night imager or laser target designator and possibly, at a later stage, radar-jamming payload. The second is the Sperwer LE (Long Endurance), also a MALE vehicle, whose payload may include a day-night imaging system, a Samir missile warning system, and a high-speed RF data link to for communications with other UAVs as well as with its ground control station. Full government support for these developments has not yet been given, although the company foresees that prototypes will be available between 2005 or 2006. The next generation of the Crecerelle, dubbed SDTI, is also in the final stages of development and testing for the French army; its design is based on that of the Sperwer UAV.

In addition to the successful penetration of the European UAV market, Sagem has also made much progress in international collaboration on R&D projects in this field. In July 2003, Sagem and STN Atlas (currently Rheinmetall Defence Electronics) of Germany signed a memorandum of understanding to begin an R&D program that will make Sagem's Sperwer UAV interoperable with STN Atlas' KZOs and Taifuns. As part of this program, a common C2 infrastructure will be developed to enable the exchange of data and intelligence gathered by these unmanned platforms.¹⁴⁹ Sagem also collaborates with General Atomics to produce the Horus-SD UAV, a European version of the Predator, and with Dassault on various UAV R&D programs.

¹⁴⁹ "Sagem, STN-Atlas Team on UAVs" *Defense News*, 14 July 2003.

Finmeccanica and its Subsidiary Galileo Avionica (Italy)

Although Finmeccanica's main business lines are in the construction of platforms, the company has been able to gain a strong foothold in the Italian market, especially in the C2 and ISR fields, largely due to the restrictive bid practices of the Italian government. It is a co-owner (with BAE) of AMS, and also owns Galileo Avionica. Both of these companies provide Finmeccanica with important expertise and contracts in the various C4ISR domains.

The company is currently also acquiring expertise in low- and medium-altitude UAVs through the development and manufacture of the tactical Mirach-26 and the Mirach-150, mainly for sale to the Italian armed forces. A more recent addition to the Galileo Avionica UAV product line is the Falco tactical UAV, designed to replace the Mirach-26. Series production of the Falco is expected to begin in 2004. A more modern and faster version of the Mirach-150, dubbed Nibbio, is also currently under development.

In 2003, Finmeccanica signed a contract with Alenia Aeronautica to codevelop a UAV demonstrator that could later become a marketable UAV or UCAV product. The Integrated Technology Vehicle (ITV) will be able to carry different payloads, including weapons, SAR, electro-optical and infrared sensors, and electronic sensors. It will also be equipped with a broadband satellite data link. Trials are expected to begin in 2004.¹⁵⁰

Alenia Marconi Systems (United Kingdom/Italy)

Co-owned equally by Finmeccanica and BAE Systems, AMS specializes in ground and naval radars, air traffic management systems, and land and naval C2 systems. In radars, it specializes in maritime surveillance radars and air defense radars; its Fixed Air Defense Radars (FADR) have been sold worldwide, including to Poland, Austria, the Czech Republic, Turkey, and Greece. In air traffic management, the company is involved in the NATO ACCS program, where it is responsible for the Sensor Integration System that will allow the connection of some 150 sensors to the main ACCS sites. In C2 systems, AMS has had experience working on the Italian army's CATRIN and the air force's mobile C2 system.

¹⁵⁰ T. Kington, "Alenia Plans New UAV, Broad Market Strategy," *Defense News*, 9 June 2003, 9.

AMS is also active in the maritime communications field, supplying both surface and underwater systems. In 2003, it completed the equipping of the British Royal Navy with a state-of-the-art communications system for its submarine fleet.

Following the signing of an MoU with American firm DRS Technologies in September 2003, AMS is currently looking to penetrate the U.S. naval C2 market and to participate in major U.S. programs, including the Littoral Combat Ship (LCS) project.

Indra (Spain)

Indra plays a key role in the implementation and upgrading of most of Spain's C4ISR programs. It is primarily focused on the integration of air and ground systems as well as on SATCOM (specifically ground segments), space-based earth observation, and C2 systems. However, the company has not had much success outside the Spanish market.

Saab (Sweden)

Saab has created a new division, SaabTech, specializing in C4ISR. The company's capabilities in this domain are focused largely on C2 systems for land, air, and sea. One product, the 9LV Mark 3E naval C3 combat system, can fuse data from sonar, radar, and electro-optic systems to create a complete picture of the seascape; it is in service with the Royal Swedish Navy as well as with the Australian, New Zealand, and Singapore navies. Another C2, which is currently under development and dubbed Wide Area Situation Picture (WASP), is an air force C2 system that will be adaptable for other services as well. Terrestrial C2 systems currently offered include the Vehicle Command and Control System (VCCS), which provides a single display unit both for tactical information and images from available sensors presented as overlays to a background digital map, and the Battlefield Command Support System (BCSS), a land forces C2 system for brigade and lower level units (the latter is currently deployed by the Australian armed forces). Additionally, Saab has moved into the UAV market. It has gained experience from its SHARC UCAV project, and signed an MoU with France's Dassault Aviation to codevelop a stealthy UCAV.

Ericsson (Sweden)

Ericsson is the only major company in the Swedish C4ISR market that is still Swedish-owned. It has been very successful in the global ISR market with products such as air defense surveillance radars (especially the Giraffe, available for both land and sea units, and recently sold to the French air force), artillery hunting radars (Arthur, sold to the Danish army and the British Royal Marines) and AEW systems (Erieye, deployed by Mexico and Greece).

Relying on its solid civilian technology base, especially in mobile communications, Ericsson has also been able to successfully penetrate the military communications market in Sweden as well as in other countries across the globe. In collaboration with Kongsberg-Ericsson of Norway and Crypto of Switzerland, it currently produces a line of state-of-the-art tactical military communications products called EriTac, which includes switches, radio relays and bulk encryption units that can be fitted together according to user requirements to build tactical area networks, air defense networks, and command post communication networks. The system has been sold to five NATO countries, including Norway, as well as to other military customers worldwide, including Kuwait and Oman.

Saab Ericsson Network Based Defense Innovation (Sweden)

This is a new company, jointly owned by Saab (60%) and Ericsson (40%). In October 2003, it was officially awarded a contract by the Swedish Defense Materiel Administration to develop the technological foundations for the future Swedish Network-Based Defense. To this end, it plans on partnering with IBM and Boeing, among others. Development work will be conducted at the R&D units within the cooperating companies.

Appendix II:

Several international interoperability fora have been established with the aim of achieving better cooperation between the United States and its allies through coordinating of their various C4ISR systems. Most of these fora deal with finding common military standards for equipment fielded by allied forces, and involve Australia, Canada, New Zealand, the United Kingdom and the United States. These fora include the American, British, Canadian, Australian Armies' Standardization Program (ABCA), the Air Standardization Coordinating Committee (ASSC), the Australian, Canadian, New Zealand, United Kingdom and United States Naval C4 Organization (AUSCANNZUKUS), the Combined Communications Electronics Board (CCEB), and the MIC. Another forum, dubbed the Technical Cooperation Program (TCCP) is not a military standardization forum, but maintains close relationships with the other above-mentioned programs to achieve its goal of coordinating between the defense R&D efforts of Australia, Canada, New Zealand, the United Kingdom, and the United States.

Of all the above-mentioned interoperability fora, the MIC is the only one to include European countries other than the United Kingdom. In 1996, when efforts were initiated to create a body that would provide oversight of coalition interoperability and assist in the implementation of actions for its improvement, the countries most likely and most capable of leading future coalitions (Australia, Canada, France, Germany, the United Kingdom, and the United States) were included as its members. Initially referred to as the Six Nation Council, it was to be almost three years before the organization's inaugural meeting in 1999, at which point its name was changed to the MIC. A year later, the member states considered granting NATO membership in MIC. However, the debate resulted merely in the extension of an invitation to the NATO Standardization Agency to accept observer status in MIC.

The MIC is led by the Joint Staff J3 (Operations Directorate), and its purpose is to provide a multinational senior level forum for addressing the core issues affecting information interoperability between coalition forces. Therefore, it is concerned with policies, doctrines, operational planning, and networking capabilities relevant to the information sharing capabilities

of member states. It serves as the senior coordinating body for the member nations in resolving interoperability issues and promotes the dialogue between operational planners, C4ISR technology experts, and defense policy analysts involved in coalition operations.

The MIC is made up of senior operations, doctrine, and C4ISR experts from each of the member nations (the lead representative is usually a flag or general officer). It is divided into Multinational Interoperability Working Groups (MIWG), each of which explore specific problems in coalition interoperability and propose solutions for them. There is no fixed number of MIWGs; they are set up when problems have been identified and disbanded after their work is done. Each MIWG is comprised of representatives from the member nations, from various services and agencies, according to the needs of the group. Current areas of interest to the MIWGs and the MIC are coalition warfare doctrine, collaborative planning, advanced C2 concepts, requirements for information exchange and the sharing of classified intelligence, secure video- and teleconferencing, and the creation of a combined WAN dubbed GRIFFIN.¹⁵¹ The four existing MIWGs therefore cover information sharing, doctrines, plans and procedures, networking and concept development and experimentation. Additionally, there is a Capstone MIWG in charge of formulating the MIC's strategic plan for the future.

The MIWGs generally meet twice a year. Once solutions have been proposed, they are passed on to the MIC, which meets annually to respond to actions and recommendations from them. If approval is given, the recommendations are passed on to the nations for implementation. However, the organization is as yet not officially designated to do more than advise and report; i.e., its recommendations may or may not eventually be accepted by the member nations. The MIC also produces an annual report on policy, doctrine, and planning relevant to interoperability in warfighting; NATO's doctrine on coalition operations is an important guide for the MIC on this matter.

An Executive Support Committee (EXECOM) assists the MIWGs in addressing actions in a timely fashion when it is not possible to convene a meeting of the entire MIWG. The

¹⁵¹ For more information about the GRIFFIN WAN, see the section on United Kingdom ISR capabilities in section 3.3 of this volume.

Committee includes a representative of each member nation's defense attaché staff in Washington, a member of the Working Group on National Correlation, and the MIC Executive Secretary (a member of the U.S. Office of the Assistant Secretary of Defense for C3I).

The MIC's reports to date have concentrated on lessons from previous coalition warfare examples (specifically, East Timor and Afghanistan), on the need for better information sharing applications between the member countries (secure teleconferencing, video conferencing and e-mail), and on a Coalition Building Guide. The latter includes the notion of Lead Nation in coalition warfare, defined as "that nation with the will and capability, competence and influence to provide the essential elements of political consultation and military leadership to coordinate the planning, mounting, and execution of a coalition military operation."¹⁵² France has voiced its concern regarding this definition, believing that circumstances may dictate the need for several Lead Nations in an operation. It also requested that the Guide state that only the United Nations can act to sanction coalition actions, a request that has not been reflected in the final version presented in 2002.

The MIC is also responsible for coordinating a series of four Multinational Experiments (MNE) that are intended to contribute to the interoperability between member nations. The first such exercise, undertaken in 2001, examined how a combined joint force headquarters would conduct rapid, decisive operations within a distributed, collaborative information environment with coalition partners. MNE2 examined the development of a multinational operational net assessment, as well as coalition multinational information sharing. MNE3, scheduled for February 2004, aims to explore concepts and supporting tools for effects-based operations and to assist the development of future processes, organizations, and technologies at the operational and joint task force levels of command. It will also include NATO participation, and evaluate the ability of the NRF to support the planning of a coalition effects-based campaign. The fourth and final MNE will further address effects-based operations and C2 issues. While some view the MIC and its exercises as key tools for France, Germany and the United Kingdom to remain

¹⁵² MIWG on Doctrine, Plans and Procedures. *MIC Coalition Building Guide*, July 2002.

cooperable with a transforming U.S. military, it remains unclear how other countries that are not involved in this forum can benefit from its lessons.¹⁵³

In Sep 2001, the CCEB and the MIC signed the Statement of Cooperation (SOC), which links the mutual interoperability interests of the CCEB and the MIC. Under this SOC, the CCEB is recognized as the expert technical body on C4 systems, while the MIC is recognized as responsible for providing leadership in joint and coalition warfare doctrine and requirements. Since the CCEB's aim is to define a joint and combined C4 interoperability environment and to enhance interoperability among C4 systems, this SOC ensures that this goal is coordinated with efforts for developing doctrines and solutions brought forward by the MIC for information sharing between countries. More importantly for transatlantic interoperability, the SOC enables non-CCEB members of the MIC—Germany and France—to be invited to participate in those CCEB groups directly involved in MIC-directed activities, and to receive status updates on CCEB activities as given by CCEB representatives at MIC meetings. The SOC has also led to some technical MIC work being subcontracted to the CCEB.

¹⁵³ For more on how the MIC can serve as a tool for transatlantic collaboration between the U.S., France, Germany and the United Kingdom, see: Boyer, Yves. "The Consequences of U.S. and NATO Transformation for the European Union: A European View". In: Hamilton, Daniel (ed.), *Transatlantic Transformations: Equipping NATO for the 21st Century*. Center for Transatlantic Relations, Washington D.C., 2004.

Glossary of Terms

Allied Ground Surveillance (AGS): NATO R&D program currently still in the design phase, which will provide the Alliance with an aerial battlefield surveillance capability through radar and the fusing of information gathered by other sensors. Initially, the system was to be deployed on manned aircraft only; more recently, the system is being redesigned for deployment on both manned and unmanned aircraft.

Galileo: Joint EC and ESA program for a space-based positioning, navigation and timing system similar to the U.S. GPS. Galileo is currently proposed to include 30 satellites and begin offering its services in 2008.

Global Monitoring of Environment and Security (GMES): Joint EC and ESA program for the development of new information systems and techniques to exploit Europe's existing space-based earth observation capabilities more efficiently and for the planning of Europe's next-generation earth observation systems.

Joint Surveillance Target Attack Radar System (JSTARS): A joint development project of the U.S. Air Force and Army providing an airborne, stand-off range, surveillance and target acquisition radar and C2 center. Sixteen such aircraft are currently operational, providing ground situation information through communication via secure data links with air force command posts, army mobile ground stations, and other command centers.

Joint Tactical Information Distribution System (JTIDS): A high-capacity, ECM-resistant communications link designed for all services (air, surface and land) and all platform types. Operates on the UHF band and supports three message standards: Link 16, the Interim JTIDS Message Standard (IJMS), and Variable Message Format (VMF).

Link-11: Tactical data link used by the U.S. Navy and several other navies. Its ability to operate on high frequency waves enables the system to communicate beyond line of sight, making it ideal for maritime communications. Link 11 can also operate in the UHF band, but is then limited to line-of-sight ranges.

Link-16: Tactical data link supporting the exchange of surveillance data, EW data, mission tasking, weapons assignments, and control data over MIDS and JTIDS equipment.

Link-22: Next-generation NATO tactical data link, also referred to as NATO Improved Link Eleven (NILE).

Multifunctional Information Distribution System (MIDS): A five-nation (United States, France, Italy, Germany, and Spain) cooperative program created to develop a third-generation Link-16 system.

Multinational Interoperability Council (MIC): Multinational body providing oversight of coalition interoperability and assisting in the implementation of actions for its improvement. The six member countries (Australia, Canada, France, Germany, the United Kingdom, and the United States) were chosen for being those most likely and most capable of leading future coalitions.

Network Centric Warfare (NCW): The use of interconnected CIS to create a shared awareness of the battlespace, which in turn enables more efficient C2 of deployed assets, better decisionmaking for commanders, and shorter sensor-to-shooter loops.

Transatlantic Industry Proposed Solution (TIPS): Defense industry consortium led by Northrop Grumman, Thales, EADS, and Galileo Avionica, General Dynamics Canada, and Indra, which submitted the winning proposal for the NATO AGS program.

Unmanned Aerial Vehicle (UAV): Remotely piloted aircraft used for a variety of military and civilian tasks. Usually categorized into tactical UAV (TUAV), which are used for short-range, low-altitude missions; MALE, used for longer, more elaborate missions; and HALE, used for long-term missions at operational and strategic levels. In recent years, smaller, man-portable and hand-launched mini- and micro-UAVs have been developed and deployed for short-term missions, as well asUCAVs for strike purposes.

Acronyms and Initialisms

ABCA – American, British, Canadian, Australian Armies’ Standardization Program
ACCIS – Automated Command and Control Information System
ACCS – Air Command and Control System
ACE – Allied Command Europe
ACLANT – Allied Command Atlantic
ACO – Allied Command Operations
ACT – Allied Command Transformation
ACTD – Advanced Concept Technology Demonstrator
ADGE – Air Defense Ground Environment
AERIS – All Environment Real-Time Interoperability Simulator
AEW – Airborne Early Warning
AEW&C – Airborne Early Warning and Control
AGS – Alliance Ground Surveillance
AJCN – Advanced Joint Communications Node
AMS – Alenia Marconi Systems
APAR – Active Phased Array Radar
ASSC – Air Standardization Coordinating Committee
ASTOR – Airborne Stand Off Radar
ATM – Asynchronous Transfer Mode
AUSCANNZUKUS – Australian, Canadian, New Zealand, United Kingdom, and United States Naval C4 Organization
AWACS – Airborne Warning and Control System

BACCS – Backbone Air Command and Control System
BCSS – Battlefield Command Support System
Bi-SC AIS – Bi-Strategic Command Automated Information System
BLD – Battlefield Land Digitization
BMS – Battlefield Management System

C@S – Collaboration at Sea
C2 – Command and Control

C3 – Command, Control, and Communications
C3I – Command, Control, Communications, and Intelligence
C4ISR – Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance
CAESAR – Coalition Aerial Surveillance and Reconnaissance
CCEB – Combined Communications Electronics Board
CCIS – Command, Control, and Information System
CEC – Cooperative Engagement Capability
CEPA – Common European Priority Area
CFIUS – Committee on Foreign Investment in the United States
CFSP – Common Foreign and Security Policy
CIS – Communications and Information Systems
CJTF – Combined Joint Task Forces
COMINT – Communications Intelligence
COMSAT – Communications Satellite
COTS – Commercial Off The Shelf
CRONOS – Crisis Response Operations in NATO Open Systems
CSABM – Collaborative System for Air Battlespace Management
CSS – Command Support System
CTAS – Cooperative Transatlantic AGS System

DARPA – Defense Advanced Research Projects Agency
DCI – Defense Capabilities Initiatives
DERA – Defence Evaluation and Research Agency
DII – Defense Information Infrastructure
DSCS – Defense Satellite Communications System

EADS – European Aeronautic Defence and Space Company
EC – European Commission
ECAP – European Capabilities Action Plan
EDA – European Defense Agency
ERG – European Research Grouping
ERRF – European Rapid Reaction Force
ESA – European Space Agency
ESDP – European Security and Defense Policy
ESM – Electronic Support Measures
EUCLID – European Cooperation for the Long Term in Defense
EUROPA – European Understandings for Research Organisation, Programmes, and Activities
EUSC – EU Satellite Centre
EXECOM – Executive Support Committee

FADR – Fixed Air Defense Radar

FLIR – Forward-Looking Infrared
FOCSLE – Fleet Operational Command System
FP – Framework Program

GPS – Global Positioning System
GMES – Global Monitoring of Environment and Security

HALE – High-Altitude, Long-Endurance

IACD – Intelligent Advisor Capability Demonstrator
IBS – Integrated Broadcast Service
IEPG – Independent European Programme Group
IFF – Identification Friend or Foe
IJMS – Interim JTIDS Message Standard
INTA – Instituto Nacional de Técnica Aeroespacial
IP – Internet Protocol
ISAF – International Security Assistance Force
ISR – Intelligence, Surveillance, and Reconnaissance
ISTAR – Intelligence, Surveillance, Target Acquisition, and Reconnaissance
ITAR – International Traffic in Arms Regulations
ITV – Integrated Technology Vehicle

JCS – Joint Command System
JFHQ – Joint Forces Headquarters
JOCS – Joint Operational Command System
JRRF – Joint Rapid Reaction Force
JRRP – Jaguar Replacement Reconnaissance Pod
JSTARS – Joint Surveillance Target Attack Radar System
JTIDS – Joint Tactical Information Distribution System
JTRS – Joint Tactical Radio System
JUEP – Joint Service UAV Experimentation Program

LCS – Littoral Combat Ship
LEO – Low Earth Orbit
LOI – Letter of Intent

M3 – Multimode, Multirole, Multiband
MALE – Medium-Altitude, Long-Endurance
MCCIS – Maritime Command and Control Information System
MCCS – Mobile Command and Control System

MIC – Multinational Interoperability Council
MIDS – Multifunctional Information Distribution System
MILSATCOM – Military Satellite Communications
MIWG – Multinational Interoperability Working Group
MMA – Multimission Maritime Aircraft
MNE – Multinational Experiment
MP-RTIP – Multi-Platform Radar Technology Insertion Program
MRS – Multi-Role Switch
MTI – Moving Target Indicator

NAC – North Atlantic Council
NACMO – NATO ACCS Management Organization
NACOSA – NATO Communications and Information Systems Operating and Support Agency
NC3A – NATO Command, Control, and Consultation Agency
NC3B – NATO C3 Board
NC3O – NATO Consultation, Command, and Control Organization
NC3TA – NATO C3 Technical Architecture
NCW – Network Centric Warfare
NDP – National Disclosure Process
NEC – Network Enabled Capabilities
NGCS – NATO General Purpose Communication System
NILE – NATO Improved Link Eleven
NMS – NATO Messaging System
NNEC – NATO Network Enabled Capabilities
NRF – NATO Response Force

ORFEO – Optical and Radar Federated Earth Observation

PCC – Prague Capabilities Commitments
PFI – Private Finance Initiative
PJHQ – Permanent Joint Headquarters
PNT – Position, Navigation, and Timing
PRT – Provisional Reconstruction Team

R&D – Research and Development
R&T – Research and Technology
RAPTOR – Reconnaissance Airborne Pod for Tornado

SAMOC – Surface-Air-Missile Operations Center
SAR – Synthetic Aperture Radar
SATCOM – Satellite Communications

SCA – Software Communications Architecture
SHARC – Swedish Highly Advanced Research Configuration
SIGINT – Signals Intelligence
SLAR – Side Looking Airborne Radar
SOC – Statement of Cooperation
SOSTAR – Standoff Surveillance Target Acquisition Radar
SSA – Special Security Arrangement
STANAG – Standardization Agreement

TCAR – Transatlantic Cooperative AGS Radar
TCCP – Technical Cooperation Program
TCDL – Tactical Common Data Link
THALES – Technology Arrangements for Laboratories for Defence European Science
TIPS – Transatlantic Industry Proposed Solution
TMD – Theater Missile Defense
TOPSAT – Tactical Optical Satellite
T/R – Transmit/Receive
TUAV – Tactical Unmanned Aerial Vehicle

UAV – Unmanned Aerial Vehicle
UCAV – Unmanned Combat Aerial Vehicle
UUV – Unmanned Underwater Vehicle

VCCS – Vehicle Command and Control System
VMF – Variable Message Format

WAN – Wide Area Network
WASP – Wide Area Situation Picture
WEAG – Western European Armaments Group
WEAO – Western European Armaments Organization
WEU – Western European Union

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