Chapter Seven

AIR SURVEILLANCE AND CONTROL

Over the past 25 years, the U.S. Air Force has demonstrated the value of an airborne air surveillance and control system. As an airborne system, the E-3 AWACS can compensate for the limitations of ground-based air surveillance and control systems by reducing the effects of radar terrain masking, by extending low-altitude radar coverage, and by extending communications and control to forces operating beyond the range of ground control centers. As a mobile system, AWACS can compensate for the limitations of fixed surveillance radars and control centers by providing radar coverage, communications, and control where it is most needed, including over enemy territory, and when it is most needed, including early in a conflict before ground centers can be established.

Several U.S. allies have also recognized the value of such capabilities, as evidenced by their acquisition of their own E-3 fleets. Table 7.1 shows the number of AWACS owned by the United States, NATO, and U.S. European allies. The United States owns and operates 32 E-3B/Cs; France owns and operates four E-3Fs; and the United Kingdom owns and operates seven E-3Ds. The NATO Airborne Early Warning Force (NAEWF) consists of two components—the E-3A component with 17 aircraft owned and operated by NATO, and the E-3D component with six aircraft owned and operated by the United Kingdom (i.e., the U.K. has “declared” six of its seven E-3Ds to NATO; they are manned predominantly by U.K. personnel[1]).

[1]The U.K. has made an agreement with NATO that the six aircraft are available when NATO requests them if they are not otherwise needed by the U.K. for national reasons.

Table 7.1

U.S. and European E-3 AWACS Fleets

Country	Number of Aircraft	Main Operating Bases
United States	32 E-3B/Cs	Tinker AFB, OK; Kadena AB, Japan; Elmendorf AFB, AK
France	4 E-3Fs	Avord, France
United Kingdom	7 E-3Ds	RAF Waddington, England
NATO	17 E-3As 6 E-3Ds[a]	Geilenkirchen, Germany RAF Waddington, England

[a]The U.K. has "declared" six of its seven E-3Ds to NATO.

The E-3A component is NATO's first and only fully integrated multinational operational unit, manned by personnel from 13 NATO nations.[2] The headquarters of the NATO Airborne Early Warning Force Command (NAEWFC) is collocated with the Supreme Headquarters Allied Powers Europe (SHAPE) in Mons, Belgium, and its commander reports to the two Major NATO Commanders (SACEUR and Supreme Allied Commander Atlantic [SACLANT]).

These AWACS programs demonstrate a long history of international cooperation among allied partners—both within the military and within industry—in developing and procuring nearly identical airborne systems for air surveillance and control. This commonality has allowed them to operate together in peacetime and in a number of military operations. For example, common systems and standardized procedures allowed NATO to combine aircraft of different nations in recent Balkan operations to accomplish military objectives. Thus, the AWACS programs provide one of the best examples of the

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They have also been available for other coalition operations. For example, E-3Ds have been in Italy since 1993 supporting various operations in the Balkans.

[2]NATO's AWACS acquisition organization is the NATO Airborne Early Warning & Control (AEW&C) Programme Management Organisation (NAPMO). Thirteen nations are full members of NAPMO: Belgium, Canada, Denmark, Germany, Greece, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Turkey, and the United States. The United Kingdom's participation is limited to attending Board of Directors meetings and other NAPMO committee meetings as required. France attends NAPMO meetings in an observer role, while the three newest NATO members, the Czech Republic, Hungary, and Poland, attend Board of Directors meetings as observers. Iceland does not participate in NAPMO. The NATO AEW&C Programme Management Agency (NAPMA) is the executive agency for NAPMO.

potential for interoperability. Because this study addresses the interoperability of U.S. and NATO allies' air forces, the following discussion focuses on U.S. and NATO AWACS programs, with selected mention of U.K. and French AWACS.

The NATO AWACS fleet has capably met NATO airborne early warning (AEW) mission requirements for almost 20 years. Several factors led to the development of a NATO program based on U.S. AWACS: a common and urgent need existed for air surveillance against a major threat (the former Soviet Union); the U.S. AWACS was the only viable option during the late 1970s; and the program integrator (Boeing) attempted to ensure fair distribution of economic benefits among participating nations.[3]

Today, several factors keep the programs synchronized and interoperable. For example, there is an enduring need for airborne air surveillance and, now, control; in the various modernization programs, there has been an equitable distribution of program cost and industrial benefits; and some formal and informal mechanisms foster interoperability (e.g., common research, development, test, and evaluation [RDT&E] and international working groups). In addition, U.S. Air Force personnel are actively involved in both the acquisition and operations of NATO AWACS, and U.S. and NATO AWACS participate in combined operations and training.

Even with this close cooperation, there are AWACS interoperability challenges. In the next section, we discuss interoperability challenges with regard to systems, missions and operational concepts, political concerns, training, and future U.S. and NATO plans. We then discuss mechanisms to foster AWACS interoperability. Next, we discuss cost implications of the NATO AWACS program. We conclude with observations and suggested actions for the U.S. Air Force.

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[3]The beginnings of the program were not free from turmoil but were marked by substantial debate, intense negotiations, and political compromise among the Alliance members. Tessmer (1988) provides a detailed account of NATO's decision to acquire its first and only collectively owned and operated defense asset.

INTEROPERABILITY CHALLENGES

Systems

Nonsynchronized fielding of AWACS system upgrades can lead to interoperability and fungibility concerns.[4] In many military capabilities, the United States is acknowledged to be ahead of the NATO nations. This is not the case for AWACS; in several ways, the NATO E-3A now leads the U.S. E-3s. The NATO Near-Term Modernization Programme (NMP) (minus the Radar System Improvement Program, or RSIP, which is part of the NMP) brought the E-3As up to approximately U.S. AWACS Block 30/35 capability in December 1997[5]; the U.S. E-3s are still being modified to the Block 30/35 configuration, with completion scheduled in FY 2002.[6] In addition, the RSIP is expected to be on all NATO E-3As by the end of January 2000, while the United States will not complete implementation on U.S. E-3s until FY 2005–2006 (U.S. initial operational capability [IOC] is expected to occur around June 2000). For missions requiring RSIP capability, only a fraction of the U.S. AWACS fleet will be interchangeable with the NATO AWACS fleet until this upgrade is completed.[7]

Moreover, NATO has planned and fully funded additional E-3A upgrades. The NATO Mid-Term Modernisation Programme (MMP) is

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[4]Fungibility concerns arise because the various AWACS fleets have very similar, if not identical, capabilities and thus are considered not only interoperable but also interchangeable.

[5]Major Block 30/35 upgrades include (1) the addition of an electronic support measures (ESM) system to passively detect, locate, track, and identify emitting air, ground, and maritime targets to improve threat warning and combat identification; (2) replacing the Joint Tactical Information Distribution System (JTIDS) 81Class 1 terminal that uses an Interim Joint Message Standard (IJMS) with a Class 2H terminal that will provide full tactical digital information link (TADIL) J message capabilities (i.e., Link 16–capable terminals), higher data rates, increased interoperability with U.S. and NATO forces, and jam-resistant transmissions; (3) a GPS Integrated Navigation System (GINS) to improve location accuracy of surveillance data; (4) and computer upgrades to support the Block 30/35 modifications. NATO's NMP does not include the GPS upgrade; that will occur during the Mid-Term Modernisation Programme (MMP).

[6]Data regarding the U.S. E-3 schedule are based on discussions with AC2ISRC/C2RS (Caragianis, 1999); by their nature, these data are subject to change.

[7]RSIP is a major AWACS system upgrade, greatly enhancing the operational capability of the radar against smaller airborne targets (i.e., those with low radar cross sections) and improving resistance to electronic countermeasures (ECMs) such as high-power jammers.

under way and will be implemented by December 2004.[8] Meanwhile, the United States is planning to upgrade the computers and displays (including a new tracker, multisensor integration, and datalink infrastructure) on its fleet when funding becomes available, possibly beginning in FY 2004. Moreover, the United Kingdom has not funded upgrades for its E-3Ds beyond NMP and RSIP. Such delays can further exacerbate interoperability and fungibility concerns.

Employment of the same or functionally similar systems does not guarantee interoperability. Development of the basic electronic support measures (ESM) system has been a U.S. and NATO cooperative program. Thus, NATO AWACS use a system similar to that of the U.S. AWACS. The United Kingdom and France have different ESM suites but are negotiating with the United States for the U.S. basic system. However, even if ESM suites are similar, their databases remain a sensitive issue because they are based on each nation's or NATO's intelligence data and thus are not necessarily shared among AWACS fleets without special agreements. During the recent NATO operation in the Balkans (Allied Force), the U.S. E-3s originally used a U.S. database; later they switched to the NATO database when it was offered because it was apparently more accurate and up to date for the theater of operations.

Although communication of tactical intelligence data is common today, the fleet capabilities may be different in the future. Currently, U.S., NATO, and U.K. AWACS can communicate with River Joint, EP-3, and Nimrod; for example, these systems can provide threat warnings or amplifying data on air tracks via Voice Product Net or Link 16. In the near future, however, terminals that receive near-real-time tactical intelligence from U.S. broadcast services will be installed on U.S. AWACS.

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[8]There are nine MMP enhancements, including the addition of a GPS-integrated navigation system; the addition of two UHF satellite communication terminals for beyond-line-of-sight communications (U.S. AWACS already has SATCOM capabilities); the addition of five situation display consoles (SDCs) to bring the total to 14 (the U.S. AWACS upgraded to 14 consoles during the Block 20/25 program); improved graphical user interface technology at all SDCs and a completely open computing system architecture (i.e., Man-Machine Interface); and integration and fusion of onboard and offboard sensor data and a new tracker to improve tracking and identification (i.e., Multi-Sensor Integration).

Initially, this capability may take the form of a standalone (i.e., not integrated with the AWACS mission software) system such as the Multiple Access Tactical Terminal. Later, this capability (specifically, receipt of the Integrated Broadcast Service [IBS]) will be incorporated in the U.S. version of the Multi-Sensor Integration (MSI) upgrade to the AWACS mission software; thus, the U.S. MSI version will be different from the NATO version developed under the MMP. To maintain fleet fungibility, the other AWACS fleets must obtain these data through other means. Otherwise, they will provide a less complete air picture to aircraft they may be controlling.

Using a "standard" system also does not guarantee interoperability. Link 16 as a standard is a moving target; "compliant" platforms are no longer compliant when the standard is changed. The various AWACS fleets have different implementations of tactical digital information link (TADIL) J message sets because they were implemented at different times. The NATO, U.K., and French AWACS are more alike than U.S. AWACS. The U.S. Navy's F-14 is not Joint Tactical Information Distribution System (JTIDS) fully interoperable with U.S. AWACS and must use voice to communicate certain data. But it is interoperable with AWACS fleets that have implemented backlink; for example, the United Kingdom and NATO have implemented backlink on their AWACS and like this particular enhanced capability, according to NAEWF representatives.[9]

Besides message sets, there is also a need to define and follow standard operating procedures, e.g., the Joint Maritime Tactical Operating Procedures for Link 16 operations, now known as the Joint Multi-TADIL Operating Procedures. However, because of Link 16's wide deployment, any difficulties with this network are the responsibility of a broader community than AWACS. (Link 16 is discussed further in Chapter Nine.)

On a related issue, there are some in NATO who would like to remove the Interim Joint Message Standard (IJMS) message set to get more time slots, but this would blind all of the NATO ground control centers unless a TADIL J translator for these centers is developed. These centers are important to NATO's European nations for Article

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[9]See Wininger (1999a).

5 operations. Thus, NATO AWACS has a system requirement that other AWACS fleets no longer have.

Missions and Operations

As discussed in Chapter Five, NATO's past emphasis has been on homeland defense (Article 5 operations), whereas the United States has conducted numerous overseas operations. Thus, the NATO AWACS has operated and trained principally to perform the early-warning surveillance mission, whereas the U.S. AWACS has been called upon to perform both the surveillance and control mission.

The original mission of NATO Airborne Early Warning (NAEW) was to augment ground-based radar systems throughout Europe to counter the low-level threat from aircraft. The emphasis was on surveillance with a limited C2 function. To European nations, "control" was a strategic concern; they wanted control of fighters over their country, i.e., air sovereignty was at stake. However, recent Balkan operations have pulled reluctant NATO nations down the path of airborne control; according to a former NAEWFC commander:

> Whilst strategic radar surveillance remains the basic role of NAEW, a more complex tactical employment of the force involving a mix of air-to-air and air-to-ground control, airspace management, air policing, combat search and rescue, force marshalling and threat warning is becoming the norm in NAEW operations.[10]

The type of control (close, tactical, broadcast, advisory) provided to aircrews depends on equipment limitations, weapon controller workload, and the tactical situation. U.S. AWACS control of U.S. fighters can range across the levels. However, for NATO partners flying less capable, austere fighters (e.g., Greece, Turkey, Italy, Norway, Belgium, and Denmark), close control may be required.[11]

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[10]See *NATO's Sixteen Nations* (1998).

[11]A mode of control varying from providing vectors to providing complete assistance, including altitude, speed, and heading.

NATO AWACS also has fewer consoles than U.S. AWACS—there are nine consoles on NATO AWACS with two or three for weapon controllers, and there are 14 consoles on U.S. AWACS with four or five for weapon controllers (the United States added five consoles in its Block 20/25 upgrade). In high-intensity conflicts, NATO controllers can be overwhelmed, especially if they are not properly trained. In such cases, the level of control over U.S. aircraft can be reduced; however, "close" control of certain NATO fighters would still be needed.

As a short-term workaround, surveillance consoles can be "converted" to control consoles. The U.S. AWACS can also do this when a maximum effort is needed; in this case, the controllers may be assigned to different functions such as check-in, tankers, offensive counterair (OCA), DCA, or strike. The long-term solution for NATO, of course, is to add five more consoles, which NATO is doing in its MMP.[12]

The introduction of stealth aircraft further complicates airspace control. It is not clear that today's ad hoc procedures using time and space deconfliction are sufficient, especially as the number of friendly stealth platforms proliferates[13] and the emphasis on coalition operations increases (there are U.S. concerns about protecting the characteristics of its stealth aircraft). In such cases, to avoid Blue-on-Blue engagements, the rules of engagement can be made very constraining, but that can increase the likelihood of Red-on-Blue engagements (with Red getting the first shot) because of delays in declaring enemy aircraft as "hostiles." Thus, there is a need to ensure that procedures, or a subset of them, developed for U.S. AWACS to perform the control functions in the presence of stealth aircraft can be provided to NATO AWACS.

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[12]Although NATO AWACS will get an additional five consoles, the participating nations have *not* stepped up to the additional manning. The United States is already low on NATO AWACS manning without the added consoles.

[13]If not now, at some point in the not-too-distant future it may be necessary for stealth and conventional aircraft to occupy the same airspace.

Political Concerns

Country sensitivities may lead to interoperability and fungibility concerns. Certain AWACS are not allowed in Turkey or Saudi Arabia, and some countries are sensitive to the fact that AWACS fleets have ESM capabilities, which can be perceived as intelligence collectors.

In high-intensity conflicts in which there are multiple ATOs, non-U.S. AWACS fleets may not be allowed by the United States to receive the U.S. ATO, which can lead to Blue-on-Blue encounters. This can be compensated for by multiple checks with higher-level C2 centers (e.g., CAOC) before declaring an airborne target as a hostile, but such checks can lead to time delays, which can lead in turn to dangerous Red-on-Blue engagements if Blue is not allowed to fire on Red until the last moment. With NATO AWACS flying about 60 percent of all AWACS sorties during the recent Balkan conflict (Allied Force), and with a 70 percent initial operating rate,[14] it would have been difficult to ensure that a U.S. AWACS was available for most U.S. sorties, especially since the bulk of sorties were flown by U.S. aircraft.[15]

Training

NATO AWACS training has historically focused on activities associated with the traditional homeland defense mission of the Alliance, in which surveillance is assigned a higher priority than control. NATO controllers are therefore not trained to handle large numbers of sorties, reflecting this priority and the correspondingly smaller number of consoles on the aircraft allocated to control.

In addition, U.S. crews have more opportunities for training, especially with fighters, than their NATO counterparts. It can therefore be difficult for NATO AWACS aircrews to achieve and maintain the same level of proficiency as U.S. crews. The NAEWFC is planning to improve its training via modeling and simulation, which should

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[14] See Proctor (1999).

[15] According to NATO data (Wininger, 1999a), the percentage of AWACS sorties flown by the four AWACS fleets during Operation Allied Force was as follows: NATO (61 percent), U.K. (20 percent), United States (13 percent), and France (6 percent). If total hours on station is used as the metric instead of sortie count, the above percentages remain the same (within 1 percent).

alleviate the problem by diversifying the types of campaigns available for training (e.g., more scenarios with out-of-area operations). A training needs analysis study is now under way at NAEWFC.

Problems associated with inadequate training were apparent during the recent Balkan operation (Allied Force). The mutual lack of familiarity between NATO controllers and U.S. fighter aircrews led to linguistic and procedural confusion. The situation was exacerbated in cases where the NATO AWACS crew were not native English speakers, and whose pronunciation degraded during periods of high activity. Differences in radio terminology were also reported, illustrating a lack of standardization on NATO procedures. All of the above had the potential to create serious misunderstandings in tactical situations.

There are also reports of insufficient training for setting up and operating the new data links. Link 11 has easy and well-defined procedures requiring one day of training to master. Link 16 is more capable and more complex, and thus one day of training is not sufficient. Some of the Link 16 problems that AWACS aircrews encounter are probably due to insufficient training (as with the TADIL J message set implementation, Link 16 training is a larger issue not limited to AWACS).

Future Prospects

Four European NATO nations are purchasing AEW&C aircraft or are considering that possibility.[16] Greece announced in December 1998 that it intended to buy four Embraer EMB-145s equipped with Ericsson Erieye radars, with deliveries during 2001–2002. Turkey intends to buy four aircraft and to select a winning contractor early in 2000. Italy plans to buy four AEW&C aircraft in 2002, and Spain plans to buy three such aircraft in 2001–2002. There is concern within NATO that these programs will take away from the respective countries' participation in the NATO AWACS program; NATO has indicated that it does not consider these programs to be "in-kind" contributions similar to the U.K.'s E-3D program.

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[16]See Hewish and Lok (999).

Greece, Turkey, Italy, and Spain have seen the value of interoperability and system commonality through their participation in NATO AWACS. They should be encouraged to develop their national systems in ways that are interoperable with the AWACS fleets at both the technological and operational levels.

There is no urgent need to replace the AWACS airframe in the near term. NATO estimates a retirement date of 2025 based on a U.S. AWACS assessment of airframe sustainability; however, a recently completed NATO study has stated that 2035 is a more likely date.[17] Furthermore, with current flying rates and assuming the aircraft are designed for 60,000 hours of flight time as Boeing states,[18] a much later retirement date, possibly to 2065, can be computed.

NAPMA and NAEWFC are developing a strategic vision beyond MMP. "Initial" results of a strategic review are due in the spring of 2000. This will not be a one-time effort; they expect to develop a "rolling" plan to account for future changes in the military/political environment, operational experience, technology advances, and equipment obsolescence. They are considering two time periods. The first period is when E-3A continues to operate. They will look at the projected lifetime for the airframe to determine the potential for a phase 2 of MMP. They are reviewing previously endorsed requirements whose implementation was deferred for reasons of affordability or technology availability (e.g., further radar and ESM improvements, re-engining, SATURN radio, Link 22). They are also looking at new requirements based on new operational concepts and will respond to externally dictated air traffic management requirements. The second period is post–E-3A. This is currently a low-level investigation that must depend on and reflect the evolution of the major NATO commanders' (SACEUR's and SACLANT's) concepts for follow-on AEW&C capabilities.

The U.S. Air Force also has many concepts for the future that could affect AWACS interoperability. The Air Force is installing the U.S. Navy's Cooperative Engagement Capability (CEC) on a test AWACS. CEC is a real-time sensor fusion system that enables a variety of air

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[17]See Wininger (1999a).

[18]See Henderson (1990).

defense systems (ground-, sea-, and air-based) on a network to exchange sensor measurement data to create common composite air tracks. CEC involves (1) high-capacity data exchange of detailed (unprocessed and unfiltered) radar and identification friend or foe (IFF) data among network participants via a directional, high-power, jam-resistant distribution system, and (2) fusion of these onboard and offboard sensor data using a common processor. If the United States integrates CEC capabilities on its AWACS and NATO does not, NATO AWACS could, at best, inject near-real-time Link 16 track data rather than raw sensor data into the real-time CEC network, assuming that a Link 16–CEC interface is developed.

The Air Force is also investigating follow-on AWACS platforms such as unmanned aerial vehicles (UAVs) and satellites, principally as sensor platforms. Placing bistatic receivers on UAVs offers the potential of increased coverage against low-RCS (radar cross section) targets. Further, the Air Force is investigating the possibility of migrating the battle management function to ground facilities, which will receive and fuse data from multiple sensors into a single operational picture. This will also provide room for additional sensor growth on AWACS and may provide a transition step to migrating sensors to UAVs and satellites. Such concepts have major implications for AWACS interoperability.

MECHANISMS TO FOSTER INTEROPERABILITY

Early and sustained emphasis on industrial participation (IP) by contributing nations' industries in the initial acquisition of NATO AWACS, the NMP, and the MMP has been one of the prime mechanisms for encouraging nations' participation, fostering system commonality, and promoting interoperability.

For example, for the MMP that is now under way, 100 percent of each nation's share of the project's costs will be spent in the nation in the form of IP by national industries. More than 70 percent of that spending will be in the form of direct IP (major AWACS subsystem development as well as involvement in production and retrofit activities), with Boeing providing its "best efforts" to distribute direct IP in proportion to a nation's contribution. NAPMA has praised Boeing for its efforts in obtaining qualified European contractors. (An interesting side note is that NAPMA was able to negotiate a fixedprice contract with incentive fee, something that is difficult for the United States to do.)

It is anticipated that overall life cycle costs can be reduced by harmonizing the designs or requirements of all AWACS users (the MMP is fostering such harmonization, particularly with the U.S. fleet). It reduces costs by paying nonrecurring costs once instead of separately for each fleet; it enhances maintainability in that spares and drawings are common among the fleets; and it reduces the time to upgrade each fleet because the bulk of the design work has been done.

Collaborative development and procurement in the modernization programs have led to common systems at lower cost, again promoting interoperability. First, elements of the NATO NMP (minus RSIP) leveraged RDT&E from the U.S. Block 30/35 upgrade. Second, RSIP RDT&E cost sharing is based on aircraft numbers—NATO pays approximately 17/49th and the United States pays approximately 32/49th of the total cost. Of course, the U.S. portion of the NATO AEW modernization program is significant, comprising approximately 41.5 percent based on NMP costs. NATO has an advantage in the RSIP production phase. NATO did a full buy over three years to reduce costs, while the United States is buying kits in small lots for same-year installs, which is less cost-effective. Third, on future upgrades, NATO will not recoup RDT&E costs from the United States when the United States implements upgrades from the NATO MMP. Later, the United States will provide a "better" tracker, the data link infrastructure (DLI) upgrade, and other software upgrades to NATO and not recoup RDT&E costs.

There are also a number of international and NATO forums and working groups, with NATO AWACS and U.S. AWACS participation, that can foster interoperability. The AWACS International Requirements Working Group (IRWG) is an ad hoc working group established to discuss common AWACS requirements and to increase harmonization among the AWACS fleets.

The Multinational AEW Commanders Conference (MACC) brings together representatives from the E-3A, E-3D, E-3F, E-3B/C, and E-2C platform communities. The NAEWFC chairs the MACC. Data link problems in recent operations were discussed at recent meetings.

The AWACS Interoperability Review Group (IORG), established in 1981, is a forum for joint consultation and coordination to ensure that interoperability is established and maintained between E-3 fleets and between those fleets and ACCS and other NATO or national systems potentially assigned to NATO operations.[19] It is cochaired by NAPMA and the primary member hosting the IORG. The primary focus has been on Link 16–related interoperability, i.e., platform implementation of the message formats (IJMS and TADIL J) and JTIDS terminal integration issues (e.g., fighter backlink discussions). The group is also discussing fighter control harmonization (between E-3s, as airborne C2, in relation to air-to-ground missions).

The JTIDS International Configuration Review Board (JIRCRB) is concerned with Link 16 issues that affect many airborne platforms including AWACS. The NAEWFC heads the NATO delegation to this international body. Finally, the NATO C3 Data Link Working Group (DLWG) is a formal group that defines standards for tactical data links; however, it is not involved in implementation.

COST IMPLICATIONS

In addition to operational benefits, the procurement and operation of NATO AWACS have probably generated cost savings for the United States. The Air Force bought a total of 34 aircraft between 1975 and 1985. NATO bought a total of 18 aircraft in the same time frame. The increase in both the buy rate and the total program quantity associated with the NATO buy probably decreased the costs of the U.S. AWACS. Although the value of the savings is uncertain, the total could easily have reached hundreds of millions of dollars, even with conservative assumptions on the buy rate and learning curve effects.

The United States funded a substantial portion of the cost of NATO AWACS, and thus the savings realized on U.S. aircraft were certainly more than offset by the U.S. share of spending for the program, which exceeded $2 billion. The actual net cost of the program to the United States is difficult to determine. In the absence of the NATO program, the United States might have felt compelled to build and

[19]See AWACS Interoperability Review Group (1996).

operate a similarly sized fleet as part of its NATO commitment. As a consequence, it might have had to bear the entire costs of the procurement program rather than the approximately 30 percent[20] share it has paid.

In addition to cooperatively funding the acquisition of the NATO AWACS, most of the NATO partners also contribute personnel and funds to operate the aircraft. The operations and maintenance costs for these aircraft are on the order of $225 million per year, with the United States paying about 41.5 percent.[21] Had the United States been forced to operate these aircraft at its own expense, it would have spent on the order of several billion dollars more than it has had to spend on the NATO program.

Cost savings for modernization have been substantial and should continue for many years to come. For example, the research and development costs of the RSIP have been funded cooperatively, with slightly over one-third of the costs funded by NATO. The net cost savings to the United States are probably on the order of $100 million. Current efforts are under way to harmonize the systems on each of the fleets to reduce the costs of future upgrades. As AWACS will continue to fill a critical mission requirement for decades to come, additional RDT&E efforts for improvements are likely.

Although NATO and U.S. AWACS are following similar upgrade paths, NATO is currently much farther along. NATO AWACS has completed the NMP upgrade and completed the RSIP upgrade at the end of January 2000. U.S. AWACS is not scheduled to complete those upgrades for another five years. Similarly, U.S. AWACS computers and display upgrades will lag NATO's MMP by a number of years. These schedule differences may reduce opportunities for savings, since the buys of common upgrade kits in any given period will be lower than they would be if the schedules were more closely aligned. These smaller buys may result in higher costs for the upgrades.

The cost implications of the NATO AWACS program for the United States have been largely favorable. Allied contributions have resulted

[20]The percentage is an estimate based on the cost information available to the authors on the NATO AWACS procurement program.

[21]See Wininger (1999a).

in lower acquisition, operations, and development costs than the United States would have had to pay had it been forced to fund a similar buy of aircraft on its own. These contributions have further lowered the costs of U.S. AWACS.

OBSERVATIONS AND SUGGESTED ACTIONS

The NATO AEW program is frequently quoted as an outstanding example of allied cooperation and as a visible and viable symbol of Alliance solidarity. Industrial participation has been a major factor in its success and has not reduced the quality of the product.

The procurement of nearly identical AWACS systems ensures a high level of interoperability between the fleets. There are also many forums in which interoperability issues can be addressed. However, materiel solutions can take time to implement because of current funding constraints.

Nonsynchronized fielding of upgrades can introduce interoperability and fungibility concerns. We list three. First, in the air surveillance function, the United States lags NATO in installation of RSIP. Thus, the Air Force should continue to support RSIP installation on U.S. AWACS and to leverage operational lessons learned from NATO experience with RSIP.

Second, NATO AWACS remains primarily an AEW platform. NATO must improve its training (an initiative is now under way) and requires additional consoles on its AWACS fleet (five are funded in the MMP) to become a control platform. However, NATO leads the United States in funding improved computers and displays that will enhance control functions. The Air Force should support NATO efforts to improve the control function (training; tactics, techniques, and procedures [TTP]; and CONOPS),[22] while ensuring that the lag in computers and display upgrades on U.S. AWACS does not create new interoperability problems.

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[22]The air control procedures employed by U.S. AWACS have proven effective over time under a variety of conditions, including MTW, peace enforcement operations, and punitive raids. Thus, U.S.-developed procedures should serve as a basis for improving interoperability between U.S. and NATO AWACS to address future needs.

Third, fielding IBS on U.S. AWACS (and not on NATO AWACS) will complicate fungibility. The Air Force should determine the impact of IBS installation on U.S. AWACS on the fungibility of the AWACS fleets with those of NATO, the U.K., and France.

Except for IBS, AWACS fleets are likely to remain largely interoperable until after 2025 (when a new platform may be needed) unless the U.S. Air Force and/or DoD implement CEC widely, have different procedures for air surveillance and control of stealth aircraft, separate C2 and sensor functions, or develop other sensor platforms (e.g., UAVs, satellites) for air surveillance.