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**GROUND SURVEILLANCE AND CONTROL**

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AWACS is an integral component of how the U.S. Air Force performs airborne air surveillance, controls the airspace, and conducts air-to-air missions. In a similar manner, the Air Force is now looking to JSTARS to perform airborne ground surveillance and attack support control for air-to-ground missions. JSTARS brings to the U.S. military a new tactical capability to detect and, within certain limitations,<sup>1</sup> track moving ground targets as well as to image stopped targets or other fixed targets in adverse weather and under night or day conditions. Its ground moving-target indication (GMTI) radar can surveil a large coverage area,<sup>2</sup> known as the ground radar coverage area (GRCA), at frequent revisit intervals and can also operate in a SAR mode to image smaller areas in the GRCA. Such a capability can support attacks of mobile enemy forces before they reach the main battle area.

JSTARS GMTI and SAR data are sent to the AOC and the Army Corps to provide ground situation awareness and to support ground-attack C2 and targeting. JSTARS is (or will be) netted with other Air Force airborne assets such as AWACS and Rivet Joint (and possibly the Airborne Battlefield Command and Control Center [ABCCC]) through Link 16. Therefore, the basic capabilities that allow JSTARS

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<sup>1</sup>Current limitations on tracking mobile targets will be reduced with the development and installation of the Radar Technology Insertion Program (RTIP) sensor and an enhanced tracking algorithm, which are part of JSTARS' preplanned product improvement program.

<sup>2</sup>The coverage area is as broad as a corps front and as deep as the location of the second echelon (Air Combat Command, 1997).

to play a central role in air-to-ground battle management and targeting support are (or are programmed to be) in place. Thus, the Air Force, in collaboration with the other services, is determining how these capabilities might best be developed and then exploited in new CONOPS for ground attack missions, such as interdiction, suppression of enemy air defenses (SEAD), close air support (CAS), and theater air and missile defense (TAMD). An example of such a CONOPS for interdiction is discussed in Chapter Eleven.

Several U.S. European allies recognize the value of developing an airborne ground surveillance capability. France has HORIZON,<sup>3</sup> a helicopter-borne GMTI surveillance radar that is flown on the Eurocopter AS 532UL Cougar. Flying at an altitude of 3 km, HORIZON covers an area of 100 km by 80 km and has a maximum radar range of 200 km.<sup>4</sup> Italy has also developed a prototype helicopter-borne GMTI radar known as CRESO.<sup>5</sup> Flying on the Agusta-Bell 412 at the maximum operational altitude of 1.5 km, the radar range is 60–70 km.<sup>6</sup> In June 1999, the United Kingdom selected Raytheon Systems to develop a SAR/GMTI radar known as ASTOR (Airborne Standoff Radar) to be carried on a Bombardier Global Express, a fixed-wing aircraft that can operate at altitudes in excess of 15 km.<sup>7</sup> Like JSTARS, ASTOR can cover a larger area than the two helicopter-borne systems and has a longer endurance.<sup>8</sup> The U.K. plans to procure five systems, with the first entering service in 2005. Figure 8.1 depicts these systems along with JSTARS' modified Boeing 707-300C aircraft.

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<sup>3</sup>HORIZON is an acronym for Helicoptère d'Observation Radar et d'Investigation de Zone.

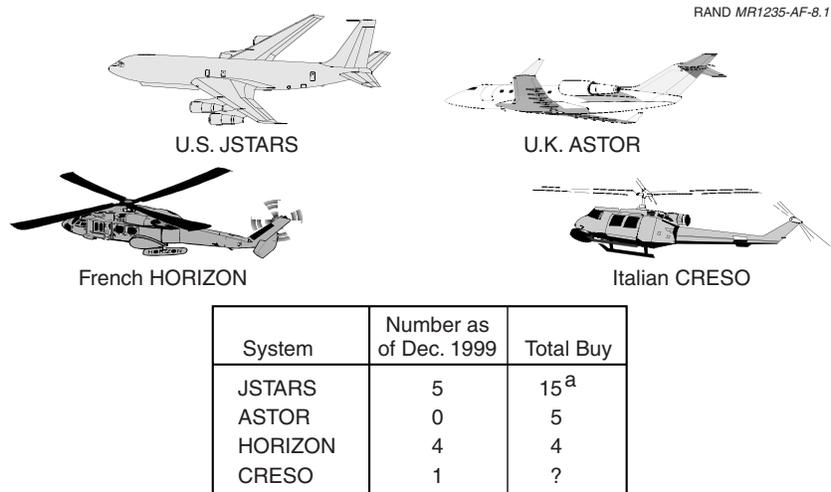
<sup>4</sup>See *Periscope* (1996) and Jackson (1999).

<sup>5</sup>CRESO is an acronym for Complesso Radar Eliportato per la Sorveglianza.

<sup>6</sup>See Jackson (1999).

<sup>7</sup>See Morrocco (1999).

<sup>8</sup>In a coalition operation, the helicopter-borne systems could be used for local battle-field surveillance in a pop-up operational mode to minimize their exposure to threats, for filling gaps in the wide-area surveillance coverage provided by fixed-wing systems (i.e., countering terrain masking and foliage), for providing confirmation (as a second sensor), or for augmenting the potentially limited number of fixed-wing systems available for the operation.



<sup>a</sup>The 15th system is in the FY01 budget and has a scheduled delivery date in FY03.

**Figure 8.1—U.S. and European Airborne Ground Surveillance Systems**

NATO has also recognized the value of a ground surveillance capability from airborne platforms and has initiated a program to develop its own capabilities:

In November 1995, the Conference of NATO Armaments Directors (CNAD) decided that NATO should acquire an Alliance Ground Surveillance (AGS) capability based on a NATO owned and operated core capability, supplemented by interoperable national assets.<sup>9</sup>

As we will see, the NATO AGS program is clearly not following the model of the NATO AWACS program, in which the NAPMO nations decided to acquire a NATO variant of an existing U.S. system, the U.S. AWACS. In the next section, we discuss AGS requirements and then highlight attempts to move beyond concept definition to an AGS program. Next, we discuss other means to achieve interoperability with the airborne ground surveillance systems of our

<sup>9</sup>See NATO Consultation, Command, and Control Agency (no date), p. 15.

allies in the event that AGS is not based on a U.S.-developed capability or is not developed at all. We conclude with observations and suggested actions for the Air Force.

## AGS REQUIREMENTS

The current AGS requirements are not definitive.<sup>10</sup> AGS most likely will consist of six to 12 fixed-wing aircraft, enough to maintain one to two orbits, and would operate in a tethered mode (i.e., within line of sight of a ground station) or a nontethered mode (using a limited-bandwidth SATCOM). The AGS would surveil a large area similar in size to the GRCA, but not necessarily with the same revisit interval as JSTARS. One AGS requirements document<sup>11</sup> explicitly mentions the need to “consider” interoperability with certain national ground surveillance systems, specifically the U.S. JSTARS, the U.K. ASTOR, the French HORIZON, and the Italian CRESO.

Discussions continue about the number of onboard consoles. A Northrop Grumman proposal has 11 consoles on an Airbus 321 as compared to JSTARS’ 18 consoles on a Boeing 707. ASTOR will have three consoles. SHAPE recommends a minimum of five consoles. Such discussions raise the issue of whether the AGS aircraft will be a surveillance platform, a battle-management platform, or both. For maximum flexibility, the platform should be able to perform both functions depending on the needs of the coalition commander, as with JSTARS. In any event, there will be a common ground station developed as part of the AGS program.<sup>12</sup>

The NC3A has created an AGS testbed to evaluate various AGS options and concepts relating to surveillance, identification, data fusion/data exploitation, interoperability, and integration of AGS data

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<sup>10</sup>The discussion in this section and the next section on the history of the AGS program and the direction provided by the CNAD is based on visits with Hamp Huckins of the JSTARS International Program, Joe Ross of the NC3A, Robert Bruce of the Office of the Deputy Under Secretary of Defense for International and Commercial Programs, and Pamela Roose of Motorola, in addition to open source material.

<sup>11</sup>See Conference of NATO Armaments Directors (1997).

<sup>12</sup>Some members believe that NATO should collectively finance and develop a common ground station only and leave the expensive sensors in the hands of the nations.

into the NATO C3I structure.<sup>13</sup> Currently, the AGS testbed comprises a number of systems representing all major candidates for components of the NATO AGS capability—specifically, the four platforms mentioned above, a German ground-exploitation and SAR simulation, the Norwegian Mobile Tactical Operations Centre, and a Danish SAR sensor. The testbed is sponsored to a large degree directly by nations, including Denmark, France, Germany, Italy, Norway, the United Kingdom, and the United States.

### AGS CONCEPT DEFINITION

Early in 1997, the United States presented a fast-track offer to NATO, over the objection of the U.S. Air Force, to provide two production versions of JSTARS (E-8C) at a reduced cost (and to be paid back at a later date) for delivery in 2000–2001. The CNAD rejected the offer in November 1997, presumably because there was no urgent need, JSTARS was an expensive solution, there were limited industrial benefits, and advanced technology transfer was minimal. The CNAD then requested fresh concepts. The United States proposed an alternative concept based on the JSTARS RTIP sensor and a platform of NATO's choice to meet the AGS requirement.<sup>14</sup>

The April 1998 CNAD reviewed the fresh concepts, including the new U.S. proposal, and endorsed two concept definition studies—an air-segment study based on the JSTARS RTIP sensor promoted by the United States and four other NATO nations,<sup>15</sup> and a common ground-segment study with the study team led by Germany. A second air-segment study based on a Standoff Surveillance and Target Acquisition Radar (SOSTAR) concept promoted by France, Germany, Italy, and the Netherlands was approved in the fall of 1998. The United Kingdom did not offer a concept and did not participate in the studies because it was in the midst of an acquisition decision on ASTOR.

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<sup>13</sup>See NATO Consultation, Command, and Control Agency (1999).

<sup>14</sup>For a description of this proposal, see Aldous (1999).

<sup>15</sup>The four NATO nations are Belgium, Canada, Denmark, and Norway. The proposal is now called NATAR (NATO Transatlantic Advanced Radar), and Luxembourg has joined the effort (see Morrocco, 2000).

At the May 1999 CNAD, the results of the three concept definition studies were presented. The CNAD elected not to make any major decisions or to provide strong direction other than to continue the studies. First, the AGS program would enter the project definition phase based on the RTIP sensor. Carrying out this option to its conclusion may be cost prohibitive for U.S. NATO allies (e.g., the recent U.K. ASTOR decision did not select a sensor based on RTIP<sup>16</sup>). Also, there is little allied support for this option without the sharing of RTIP technology. Finally, with allied emphasis on AGS support to the ground commander, there is no agreement on the need for a large aircraft with significant battle management capabilities, a function that can be performed at ground stations.

Second, the SOSTAR group would continue to evaluate its sensor concept. In the near term, this appears not to be a viable option. In the best of circumstances (adequate funding, significant industrial mobilization, and appropriate international agreements), the option would not be timely and most likely would not be available for more than a decade. However, with reduced European defense budgets, the nations are unlikely to support the development of such an expensive, advanced sensor.

Third, the common ground station team, which includes U.S. and European contractors, would continue to refine their concept. This is an important segment to the Europeans because of their interest in providing support to the ground commander and because some nations believe the focus on AGS should be on the ground station and not the sensor. A U.S. contractor (Motorola) that has experience in developing ground stations for sensor platforms (e.g., the U.S. Army's Common Ground Station, the JSTARS Joint Service Workstation, and the new ASTOR workstations—both the onboard console and the offboard workstation) is providing substantial support to the team.

At a future CNAD, the United Kingdom may enter its ASTOR program into the NATO AGS competition; a second possibility is that the U.K. may “declare” ASTOR to NATO as it did with the E-3Ds. It is unlikely that the NATO nations will base the AGS on an ASTOR solution

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<sup>16</sup>The U.K. selected the Raytheon proposal, which includes a SAR/GMTI radar derived from the ASARS 2 Improvement Program (AIP) employed on the United States' U-2 aircraft (see Morrocco, 1999).

because of concerns over industrial participation, the U.K.'s selection of a U.S. contractor, and the program's greater emphasis on collecting SAR imagery rather than performing GMTI detection and tracking of moving targets. Although the U.K. has rejected the U.S. offer to participate in RTIP development, the U.K. may still buy RTIP as a possible midlife update to ASTOR, thereby increasing the number of more capable theater ground surveillance systems available to a coalition commander.<sup>17</sup>

### **OTHER MEANS TO ENSURE INTEROPERABILITY**

Because development and procurement of a NATO AGS system is uncertain and, even if acquired, unlikely to follow the NATO AWACS path, the United States should look to other means to ensure interoperability for ground surveillance and control of air-to-ground missions. The ability of JSTARS and U.S. ground facilities to gain access to and exploit GMTI data from a NATO sensor or other European capabilities may be important in areas of operation where visibility is impaired by environmental factors (terrain, foliage, etc.), when JSTARS (or other U.S. GMTI sensors such as the U-2 and the Army's Airborne Reconnaissance Low [ARL]) are not flying, or when multiple sensors are needed to increase confidence in reported information (i.e., confirmation).

One method is to improve interoperability at the ground station segment. The Coalition Aerial Surveillance and Reconnaissance (CAESAR) initiative proposes to improve near-term interoperability among U.S. and European airborne GMTI capabilities (candidate capabilities include those being simulated at the NC3A's AGS testbed). The objectives of CAESAR are to make U.S. and coalition ground surveillance assets interoperable to maximize the military utility of scarce and expensive resources and to enable synergistic use of differing GMTI capabilities, including coordinated mission tasking, planning, and operations.<sup>18</sup> CAESAR was a standalone demo at the

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<sup>17</sup>The "other" European options—the French and Italian helicopter systems—are not fungible with JSTARS; they are local Army support assets and are not designed for theater surveillance, although they could augment theater assets such as JSTARS or ASTOR.

<sup>18</sup>See Ross (1999a).

Air Force's Joint Expeditionary Force Experiment (JEFX) 99 and is proposed as a five-year, \$20 million FY 2000 advanced concept technology demonstration (ACTD).

The initial focus of the ACTD would be on the output of the ground stations, particularly the development of a common data exchange format for transmission of GMTI data. Currently there is no single standard for GMTI reporting, and the problem will increase over time as new GMTI capabilities are developed. At JEFX 99, the NC3A's EX 2.01 data format was used; in the ACTD, the EX format will be enhanced to incorporate new capabilities such as high-range-resolution (HRR) GMTI data. The ACTD builds on an earlier version of the data format that was used at the Paris Interoperability Experiment (PIE) conducted by the NC3A in 1997 with the participation of the United States, France, Italy, the United Kingdom, and the Netherlands. The EX format is also a requirement for the ASTOR program.

In addition to the common data format, other residual products of the proposed CAESAR ACTD include advanced GMTI algorithms (e.g., identification, tracking, prediction, and fusion) and coalition interoperability CONOPS and TTPs for sensor employment (e.g., gap filling, sensor cuing, optimal phasing, and common MTI picture).

CAESAR is an initial step toward ground surveillance interoperability at a time when GMTI resources are scarce. CAESAR will also support the interoperability requirements of the NATO AGS (note that CAESAR is not a substitute for the NATO AGS).

A number of working groups are concerned with the interoperability of sensor systems in general and GMTI systems in particular. The Standing Interoperability and Applications Working Group on Intelligence, Surveillance, and Reconnaissance (SIAR WG) is tasked to define options, study techniques, and recommend solutions for achieving interoperability between NATO ISR systems, both manned and unmanned.<sup>19</sup> This working group reports to Air Group IV, which is responsible for promoting ISR cooperation and standardization for

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<sup>19</sup>See Air Group IV (1999b).

the NATO air armaments community.<sup>20</sup> The working group has been focusing on imagery interoperability architectures and related standards.<sup>21</sup> At a recent meeting, the SIAR WG was tasked with assembling a technical support team to investigate the need for a NATO GMTI data standard and, if such a need was found, to determine whether to create a new standardization agreement (STANAG) or to modify an existing one.<sup>22</sup>

The Standoff Surveillance and Target Acquisition Systems (SOSTAS) Interoperability Ad Hoc Working Group (SI AHWG) is a recently created working group tasked by Air Group IV to address the interoperability of ISR systems to improve the effectiveness of NATO forces.<sup>23</sup> The working group will address all image collection systems, including GMTI systems,<sup>24</sup> and will provide a report at the end of 2000.

The purpose of the Common GMTI Format Working Group is to define a set of GMTI standards for U.S. producers, such as JSTARS, U-2, Global Hawk, and Discoverer II, to facilitate the transmission, processing, fusion, and display of GMTI data (Boone, 1999). Developing a standard is not, however, a simple process. It concerns data formats and available data rates between the following nodes: (1) the sensor and the platform processing or preprocessing capability, (2) the platform and the ground processing or final processing segment, (3) the ground processing segment and the

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<sup>20</sup>Air Group IV is one of six subordinate groups that comprise the NATO Air Force Armaments Group (NAFAG). The NAFAG is one of three main armaments groups (the other two are army and navy groups) subordinate to the Conference of National Armaments Directors (CNAD), which in turn reports directly to the NAC.

<sup>21</sup>The working group is responsible for the following NATO STANAGs: NATO Secondary Imagery Format (STANAG 4545), NATO Standard Imagery Library Interface (STANAG 4559), NATO Advanced Data Storage (STANAG 4575), NATO Primary Image Format (STANAG 7023), Air Reconnaissance Tape Recorder Standard (STANAG 7024), and Interoperable Data Links for Imaging Systems (STANAG 7085).

<sup>22</sup>See Nethercott (1999).

<sup>23</sup>See Air Group IV (1999c), and SOSTAS Interoperability Ad Hoc Working Group (1999).

<sup>24</sup>An MTI subgroup was established to (1) investigate the use of MTI products in surveillance, situational awareness, targeting, and tracking, (2) explore the use of MTI products and identify necessary collateral data, (3) define architectures and interfaces needed to handle MTI data, and (4) recommend MTI standards and data formats.

exploitation system, and (4) the exploitation system and the archiving or dissemination system.

The working group expects to define a format—possibly a hybrid format—by the end of December 2000, with formal coordination within the United States and adaptation discussions with the international community scheduled to take place in 2001. The Office of the Secretary of Defense (OSD) has endorsed the outcome of the working group as the DoD standard. The working group is composed primarily of U.S. government and industry representatives; however, the group is also coordinating with the SOSTAS Interoperability Ad Hoc Working Group and the CAESAR initiative. Representatives from these groups, as well as interested parties from other nations, are invited to group meetings.

## **OBSERVATIONS AND SUGGESTED ACTIONS**

It is not clear when or if there will be a NATO AGS. The program is clearly not following the NATO AWACS history—RTIP is meeting strong resistance, and other options, albeit with more limited capabilities, exist or will exist. If the AGS program proceeds, interoperability may occur only at the output of the ground station segment.

Initiatives such as CAESAR offer the promise of near-term interoperability among coalition airborne GMTI systems through use of a common data standard at the output of the ground station segment. This could also support NATO AGS interoperability needs if interoperability is so defined. Thus, the Air Force should evaluate the results of the CAESAR demonstration at JEFX 99 to determine the value of receiving, exploiting, and fusing ground surveillance information from the ground segments of the different airborne GMTI systems. The Air Force should also investigate the value of receiving European GMTI data on board JSTARS and determine a mechanism for JSTARS to receive such data.

One solution that would lead to greater interoperability lies in the creation of a standard GMTI data format that could be used by all GMTI producers and users (not just the ground station segment) for the transmission, processing, fusion, and display of GMTI data. The Air Force should continue to support the development of a common GMTI data format for U.S. and European GMTI assets.

Finally, the Air Force should help harmonize U.S., NATO, and European allies' GMTI capabilities by supporting the development of a multisensor operational employment concept to ensure that European assets can complement JSTARS.