ARCHIVED REPORT

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AMSAR

Outlook

- Knowledge obtained from the AMSAR program will advance European radar technology
- In May 2009, EADS announced that the AMSAR program concluded with the delivery of flight trial data analysis and data evaluation reports for technical institutions and procurement agencies of France, Germany and the U.K.
- After data review, procurement agencies could issue further AMSAR contracts
- Baring further information, this report will be archived in 2011

Orientation

Description. The X-band Airborne Multimode Solid-state Active-array Radar (AMSAR) is a next-generation, steerable, phased-array system being developed for the European tactical fighter market.

Sponsor

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Status. AMSAR was a Technology Demonstrator Program (TDP).

Total Produced. It is believed two or three prototypes were produced.

Application. AMSAR is being developed for future European production programs. The system may also be used for midlife upgrades (MLUs) of Eurofighter Typhoons.

Price Range. AMSAR is a technology development program; the cost of a production AMSAR radar system cannot be fixed at this time.

Contractors

Prime

EADS Deutschland GmbH, Division HQ	http://www.eads.com, Willy-Messerschmitt-Strasse, Ottobrunn, 85521 Germany, Tel: + 49 89 607 0, Fax: + 49 89 607 26481, Consortium Member

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Technical Data

Design Features. AMSAR is an X-band, active phased array, steerable radar based on gallium arsenide (GaAs) Monolithic Microwave Integrated Circuit (MIMIC) technology. The radar will have power management and reliability improvements over traditional radars, according to the manufacturer.

The new system will be expected to perform multifunction operations in a high-threat, high-ECM environment. Besides high electronic counter-countermeasure (ECCM) capability, it will have stealth and range detection capabilities, as well as mixed air-to-air and air-to-ground tasking abilities. The most significant advance will be the use of adaptive beam-forming, which allows the nullification of directed jamming and/or the simultaneous control of missiles while the radar conducts search-and-track modes.

Another advantage of an active-array system over conventional radar is that it does not have to be integrated into the nose radome. Instead, a number of the arrays are placed around the aircraft, thereby reducing the forward cross-section while providing side-looking radar coverage.

According to GTDAR (GEC-Thomson-DASA Airborne Radar), a consortium formed for AMSAR development, the first flying prototype was expected to be tested in 2002. While the ground system was composed of 144 transmitter/receiver modules, the flight test version will be composed of 1,000 modules. The final production version will incorporate between 1,500 and 2,000 modules, as well as an energy-management function. The energy-management function will regulate power distribution among the modules in order to obtain all necessary targeting information while minimizing the risk of detection.

Laboratories working on AMSAR include the U.K. Defence Research Agency (DRA), French Centre Electronique de l'Armement (CELAR), and German Forschungsgesellschaft für Angenwandte Naturwissenschaften (FGAN).

MIMIC. A MIMIC is formed when a complete circuit is manufactured on a single piece of semiconductor material. MIMICs allow the processing and transmit/ receive modules to be miniaturized, while keeping power/signal losses at a low level. MIMIC technology is also easier to cool than earlier technologies.

The European MIMIC effort is almost exactly the same program that has provided the U.S. DoD with highly advanced microwave and millimeter-wave technologies. The program is based on GaAs chips and boards. The European program had to overcome the same problems faced by the U.S. with respect to reducing high manufacturing costs and resolving the power generation and thermal efficiency problems that are inherent to GaAs boards.

A MIMIC board also requires the use of a direct-write electron beam in order to generate board features of 0.25 microns or smaller. It is estimated that the U.S. has a five- to seven-year jump on MIMIC technology over the rest of the world.

Program Review

Background. In 1993, GEC-Marconi (now BAE Systems) and Thomson-CSF (now Thales) were awarded a contract to develop a joint Anglo-French next-generation radar. The plan included a 4½-year feasibility and development phase leading to development of various solid-state materials and ground-based array demonstrators. Following the development phase was the 7½-year construction and evaluation phase that would lead to a flyable demonstrator by 2005.

The new radar is to provide Europe with a solid-state, active, steerable, phased-array system analogous to the U.S. F-22 Raptor radar. This X-band project is

designated AMSAR (Airborne Multimode Solid-state Active-array Radar), and the GTAR (GEC-Thomson Airborne Radar) consortium was formed to develop the system.

Although both GEC-Marconi and Thomson-CSF had the technical expertise to develop AMSAR, neither company had the funding. With the formation of GTAR, the developmental contract was finally awarded by the French government, which also oversees and administers developmental work. The U.K. DRA supplied a wealth of data on its airborne, multirole, solid-state, active-array radar program as its contribution to AMSAR.

Additional funding was secured from both the French and U.K. governments. The funding was expected to be a 50/50 split between GTAR and the French/U.K. Ministries of Defense. Exact figures have not been released, but it is known that the government-funded portion was not an even split between the U.K. and France. Estimates indicated that the entire 11- to 12-year development cost would total approximately $170 million (1998 dollars).

Most of the initial-phase funding was spent on gallium arsenide (GaAs) monolithic microwave integrated circuits (MIMIC) that allow the processing and transmit/receive modules to be miniaturized and keep power/signal losses at a low level. In addition, MIMIC technology is easier to cool than earlier technologies.

EADS Joins GTAR

By 1996, Germany's Daimler-Benz Aerospace (DASA) (now EADS) had joined GTAR on the AMSAR project and other programs. GTAR was renamed GTDAR (GEC-Thomson-DASA Airborne Radar). This new arrangement has eased funding concerns. The funding split was renegotiated, with the three governments (U.K., France, and Germany) paying a slightly larger share. Additionally, each company would handle future domestic sales, with GTDAR controlling export orders.

In 1998, a 144-module array utilizing an advanced MIMIC – featuring a custom ASIC (application-specific integrated circuit) and a multilayer ceramic substrate housing a metal matrix composite – was successfully tested. Reportedly, a bench scale model was constructed, demonstrating the overall feasibility of the project. The project would now proceed to the next phase, which called for a 1,000+ module full-scale unit. The full-scale unit would subsequently undergo flight testing aboard a BAE Canadair avionics test aircraft.

Swedish Interest in AESA

In August 1998, Ericsson Microwave Systems (now Saab) approached the GTDAR consortium about merging Ericsson's and GTDAR's respective phased-array radar projects. Ericsson was working on an active electronically scanned array (AESA) radar, which was already substantially ahead of AMSAR. It can be inferred that the Ericsson AESA system did not have all of AMSAR's capabilities.

In November 2006, Saab Microwave, SELEX Sistemi Integrati, and Electronica were awarded a contract to support the development of the next generation of microwave, multifunction, multi-role AESA systems known as M-AESA. The governments of Italy and Sweden financed this work.

Contract Award and Flight Trials

In the February 2004 edition of *FLUG REVUE* (Bonn, Germany), it was reported that the GTDAR consortium had been awarded a Phase 2B contract, worth EUR60 million (approximately $71 million). This contract covered antenna and system integration, ground and flight testing, and multichannel signal processing, and at the time contract work was expected to run to 2008.

In September 2006, *Flight International* published that the first flight of an AMSAR AESA demonstrator would take place on a QinetiQ-operated BAC-111 aircraft in 2007.

An article in the July 2008 issue of *Military Technology (MILTECH)* stated that the AMSAR E-Scan demonstrator provides advanced adaptive beamforming (ABF) for jammer suppression and Space-Time Adaptive Processing (STAP) for jammer suppression and for the detection of slow-moving objects in clutter. The report also stated that the system's functional capabilities were successfully demonstrated during ground trials in France and flight trials in the U.K., Germany and France with the AMSAR E-scan demonstrator installed on a BAC-111.

According to *MILTECH*, during flight trials, the AMSAR E-Scan demonstrator displayed advanced functionality, especially with regard to ABF and STAP processing. The next step after flight trials was the analysis of data and the preparation of reports for the procurement agencies and technical institutions of France, Germany and the U.K. After review, the procurement agencies may issue a further contract to the GTDAR consortium.

AMSAR

Funding

Total RDT&E funding for AMSAR is estimated at $230 million.

Contracts/Orders & Options

FLUG REVUE reported in Feb 2004 that the GTDAR consortium had been awarded a EUR60 million ($71 million) contract for Phase 2B. This contract is believed to cover antenna and system integration, ground and flight testing, and multichannel signal processing, and at the time work under the contract was expected to be completed in 2008.

Timetable

Month	Year	Major Development
	FY93	Thomson-CSF and GEC-Marconi win contract to develop an active-array radar system for the next-generation combat aircraft
	FY93	Anglo-French consortium GTAR formed to develop AMSAR
	1996	DASA joins GTAR, which is subsequently redesignated GTDAR
	1997	Ground-based AMSAR demonstrator
Aug	1998	Talks begin to combine Ericsson AESA program with AMSAR
	1998	Completion of Phases 1 and 2 of program: study of feasibility and requirements of new-generation active arrays and new methods for MIMIC module fabrication
	1999	DASA announces the expansion of its MIMIC production plant to a capacity of 60,000 modules a year by 2002
	2003	Contract award of $71 million for Phase 2B: antenna and system integration, ground and flight testing, and multichannel signal processing
	2007	Scheduled first flight of Europe's AMSAR AESA demonstrator
	2007	Negotiations set to begin for Eurofighter Tranche 3
Mid-	2008	Scheduled completion of Phase 2B tasks
	2008	Successful flight test of AMSAR E-scan demonstrator on BAC-111 aircraft
	2009	EADS announces conclusion of AMSAR program with delivery of reports

Worldwide Distribution/Inventories

AMSAR is a joint effort of the **United Kingdom**, **France**, and **Germany**.

Forecast Rationale

The Airborne Multimode Solid-state Active-array Radar (AMSAR) is a Technology Demonstrator Program (TDP) to advance radar knowledge and develop the next-generation airborne radar for the European tactical fighter market.

CAESAR and CECAR

It has been speculated that the Eurofighter Typhoon will be AMSAR's first platform. Eurofighters are currently equipped with the Euroradar Captor radar. The newest variant of Captor is Captor-E (Electronically scanning). A CAESAR (Captor Active Electronically Scanned Array Radar) demonstrator completed a flight test program aboard a Eurofighter Typhoon in May 2007. The Euroradar consortium, which manufactures CAESAR, is made up of Germany's EADS, Spain's Indra and SELEX Galileo offices in Italy and the U.K.

In the early 2006 timeframe, the CAESAR was loaned to the CECAR evaluation program. CECAR (Captor E-sCAn Risk reduction) is a strand of AMSAR, with Germany and the U.K. participating, with a focus on the Eurofighter. Instead of joining CECAR, France (Thales) chose to focus on the Rafale aircraft. In May 2009, EADS announced the conclusion of the CECAR program.

The ECR-90 (Captor) radar is covered in a separate Forecast International report.

Less Risky

In December 2005, U.K. Defence Secretary John Reid remarked in Parliament that the future lies in supporting and upgrading hardware, not manufacturing new hardware. Secretary Reid said that the Eurofighters would have a very long service life. A midlife upgrade with AMSAR is therefore a possibility.

A Eurofighter agreement signed in June 2007 introduced new capabilities and referred to the CAESAR antenna as "just one of a number of industrial proposals for future enhancements of Typhoon to go into customer consideration."

CAESAR's advantage over AMSAR is that it uses many of the back-end elements of the current Captor radar and would be more cost-effective. Only the front array, antenna power supply, and antenna controller are new. CAESAR also represents less overall program risk than AMSAR because it requires fewer new components. The Euroradar CAPTOR-E brochure markets CAPTOR-E as a low-risk upgrade to CAPTOR-M (mechanically scanning radar).

Eurofighter Tranche 3

The first Eurofighter Typhoon contract was signed in January 1998 for 620 aircraft with production to be divided into three Tranches. Tranche 1 deliveries to the four partner nations ended in March 2008. Tranche 2 deliveries are scheduled to be completed in 2013.

Both the U.K. and Italy asked Eurofighter GmbH to provide options for reducing the number of aircraft purchased under Tranche 3. The decision was made to split Tranche 3 into two production runs.

In July 2009, a contract was signed for a further 112 Eurofighter Typhoon aircraft for the partner nations. This Tranche 3A effort is approximately half the size of the original quantity planned for Tranche 3, which was 236 aircraft. Tranche 3A aircraft will be delivered between 2013 and 2016.

It is unclear if there will be a Tranche 3B order; a decision is scheduled for 2011. Under the terms of the umbrella contract, it would have 124 aircraft. If a Tranche 3B contract is signed, it is expected to be for fewer aircraft due to reduced defense budgets. Tranche 3B aircraft would be delivered between 2016 and 2019.

AMSAR Unlikely to Fly on Other Platforms

An AMSAR upgrade of aircraft other than the Eurofighter Typhoon is improbable. The Dassault Aviation Rafale is currently equipped with the Thales RBE2 radar and Thales is in the midst of delivering its first RBE2 AESA radar to Dassault Aviation for installation on a Rafale.

The Swedish Air Force JAS 39 Gripen flies with the Saab Microwave Systems PS-05/A radar. Saab and SELEX Galileo entered a partnership in March 2009 to develop an AESA radar for the Gripen Next Generation (NG) program. The new radar will be based on SELEX Galileo's Vixen AESA radar and Saab's PS-05/A radar.

AMSAR – Concluded

The July 2008 issue of *Military Technology (MILTECH)* reported on AMSAR E-Scan demonstrator flight trials. The next step after flight trials is the analysis of data and the preparation of reports for the procurement agencies and technical institutions of France, Germany and the U.K.

In May 2009, EADS announced that the AMSAR program concluded with the delivery of data evaluation reports. After review, the procurement agencies may issue a further contract for AMSAR work to the GTDAR consortium.

In order to win a Eurofighter production contract, an AMSAR radar would have to have more capabilities than CAPTOR-E, have no greater risk and the cost would also have to be similar. Contracts in the future for an undetermined platform may be possible.

Ten-Year Outlook

The AMSAR program concluded in May 2009, therefore a Ten-Year Outlook is not included.

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