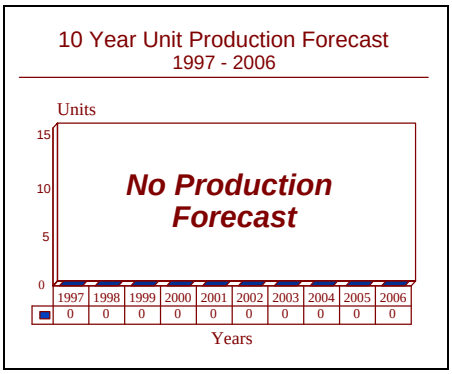
ASARS-2 - Archived 12/97

Outlook

- Ground mapping radar for U-2
- No further production programmed, but the technology and some components finding their way into other programs
- Supported from O&M account
- ISAR upgrade planned



Orientation

Description. Advanced synthetic aperture radar surveillance system.

Sponsor
US Air Force
AF Systems Command
Aeronautical Systems Center
Wright Patterson AFB, Ohio (OH) 45433
USA
Tel: +1 216 787 1110

Contractors
Hughes Aircraft Co
Radar & Communications Systems
P.O. Box 92426
El Segundo, California (CA) 90009-2426
USA
Tel: +1 310 334 1665
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[Acquisition by Raytheon tentatively approved (Prime)]

Lockheed Martin Corp
6801 Rockledge Drive
Bethesda, Maryland (MD) 20817
USA
Tel: +1 301 897-6711
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(Ground Station)

Status. In service, ongoing logistics support, upgrades pending.

Total Produced. An estimated 35 ASARS systems have been produced. There are 36 U-2R (including 4 trainers) in the active Air Force inventory. None are assigned to AF Reserve or National Guard units.

Application. U-2R (TR-1A). E-2R NASA research aircraft, can carry ASARS.

Price Range. Estimated unit cost is US$4.2 million.

Technical Data

Dimensions	**Metric**	**US**
CBSP Processor (ground):		
Weight:	68 kg	150 lbs
Volume:	0.18 m^3	6.5 ft^3
Size:	43 x 58 x 69 cm	17 x 22.75 x 27.2 in
Replacement Airborne Processor (proposed)		
Weight:	43.1 kg	95 lbs
Characteristics		
Range (est):	165 km	102 mi
Frequency:	8 to 12 Ghz	
Resolution:	Better than 18.3 m	Better than 60 ft
Units:	Electronically Scanned Antenna Transmitter Receiver/Exciter Control Display Unit Processor (CBSP) Power Supply	
Operational Modes:	Moving-Target Search Moving-Target Spot Stationary-Target Search Stationary-Target Spot	
U-2R		
Range:	2,609+ nm (6,400 km)	
Ceiling:	+ 70,000 ft (21,212 m)	
Speed:	475+ mph (Mach 0.58)	

Design Features. The Advanced Synthetic Aperture Radar System-2 (ASARS-2) was designed to provide high-resolution, long-range radar ground maps in all weather conditions, day or night. Radar data is transmitted in near real time to ground stations for tactical analysis. It is one of the modular sensor packages carried by the U-2R. The ASARS-2 sensor is carried in a special forward Q-Bay in the nose of the aircraft. It is characterized by a special cooling intake on top of the nose.

ASARS-2 employs a synthetic aperture radar (SAR) with side-pointing antennas to detect and locate stationery or moving targets on either side of the aircraft. The U-2R can gather detailed information on selected portions of the coverage area. The radar uses a dual planar array antenna oriented perpendicular to the U-2's flight path. It can map the area on either side of the flight path without changing aircraft or radar antenna orientation. The radar produced constant-scale imagery in plan view, even at long range, with ground resolution independent of range. Increased resolution can be achieved with the 'spot mode' by changing the look angle of the antenna to repeatedly map a small area of interest.

The radar has several classified search modes. Development of ASARS grew out of a need by NATO forces in Europe, to observe second-echelon areas of the then-Warsaw Pact forces. A wide-band data link transmits radar data to a ground station for processing and analysis. Operators can select the mode, resolution, and search area for the radar.

The Side-Looking Airborne Radar Program (PE#0604756F) funded the development of high-resolution radar components for airborne imagery collection. The objective was to develop and test advanced resolution SLAR components and systems capable of collecting radar imagery on ground targets from an airborne platform, followed by transmission, processing, and exploitation of the imagery to yield reconnaissance and strike information at night and under adverse weather conditions.

Near-real-time imagery exploitation is carried out in a transportable ground processing station, the Multi-Sensor Exploitation System (MSES) which processes the received data into exploitable tactical information. The units use a flexible imaging and data-processing system to accomplish the necessary intelligence reporting and imagery

dissemination. The ground station is air transportable and can be mounted on select ground vehicles.

The Air Force is upgrading ASARS ground stations with new processors. The Commercial Off-the-Shelf-Based (COTS) Signal Processor (CBSP) features scaleability, extensibility, software portability, and low cost. The Image Information Processor is made up of 38 Intel i860XR processors on three modules. The Host Computer is a SUN 600 Series Dual SPARC CPU module. Both have a 9U VME factor.

The processor is small and light, and a ruggedized version is being developed for airborne applications. CBSP will interface with the TAC 3/4, CARS, and JSIPS systems. The architecture was designed to be upgradable, and could be software-modified to process MTI and F/A-18 RECCE data.

There are proposals active to add as Moving Target Indicator (MTI) capability to the radar. A new prototype airborne multi-mode radar processor has been flight tested for delivery to the Air Force. It is based on the new ground processor.

Operational Characteristics. The U-2R is a primary USAF airborne reconnaissance platform and the only high-altitude, air-breathing reconnaissance aircraft of its type in the inventory. As a battlefield surveillance sensor, ASARS-2 can locate and monitor fixed or semi-fixed surface targets using the radar's broad area search or spotlight modes to develop photo-like radar maps of a target area, downlinking the imagery to a ground station for viewing in real time.

Imagery-derived target location reports are sent to users, including battlefield command centers, intelligence centers, and strike systems such as the Combat Operations Intelligence Center and the Joint Surveillance and Target Attack Radar System (JSTARS). The ground station can direct the aircraft to obtain additional coverage of the target area.. During the Persian Gulf War, typical deployment was to fly a photo reconnaissance mission during the day, followed by an ASARS mission at night.

The ASARS-2 radar has four basic operational modes, two for moving and two for stationary targets. They are:

MOVING TARGET INDICATOR MODES

Search: A wide-area MTI mode provides selectable cartographic or synthetic aperture radar background information highlighted by moving-target activity.

Spot: Improved detection and location capabilities characterize this MTI mode. It can detect both slow and fast-moving targets, group and count individual targets, and overlay these targets on a synthetic aperture radar background.

STATIONARY TARGET MODES

Search: This mode provides large area coverage with the ability to detect and locate targets. It provides large target discrimination.

Spot: This mode provides greater target detail and small-target discrimination.

Besides military missions, the U-2 has been used to support Army Corps of Engineers, state governments, and the Federal Emergency Management Agency (FEMA) to support coping with natural disasters. This included providing radar images during the floods in the Midwest in 1993 and Northern California in 1995, as well as the Northridge, California earthquake in 1994. The aircraft was used for surveillance during the Malibu, California, fires and to evaluate damage after Hurricane Andrew.

The U-2R can be configured for a variety of specialized missions by changing modular sensor packages. Plans are for the U-2 to remain operational until 2035.

Variants/Upgrades

In August 1994 the Air Force contracted for the new CBSP (signal processor). The new processor will feature newer technology, flexibility, and software portability.

An airborne version was successfully flight tested in late 1995. Commonality will make it possible to use a common software baseline for both the ground and airborne computers. It has been proposed as the basis for the Air Force radar improvement plan. The new processor will increase resolution and coverage and make adding an MTI capability possible. It will make it possible to provide ASARS-2-derived digital maps to ground commanders for better assessment of force composition and location.

The upgrade program to provide an Enhanced MTI mode began in March 1995. By the beginning of 1996, one aircraft flying out of Korea had received the EMTI upgrade and a second modification was in process. Plans were to upgrade eight more in the near future.

IFSAR. Plans are to develop an interferometric synthetic aperture radar for the U-2 and high-altitude endurance UAVs. The Senate Select Committee on Intelligence added US$6 million to the FY98 intelligence authorization to begin the development. An IFSAR is scheduled to fly on the Space Shuttle around 2000. The upgraded radar will be designed to provide improved targeting and terrain information for better targeting of precision guided munitions.

Program Review

Background. The U-2 first flew in 1955, carrying cameras and radioactivity sensors. One of the U-2's most famous missions was photographing the Soviet military in the act of installing offensive missile sites in Cuba.

Follow-on development of ASARS was initiated in 1972. Joint funding began in 1977 with a contract awarded to Hughes to develop the system. Contractor integration and testing of the SLAR portion of ASARS occurred in 1979, with ground processing equipment testing following in 1983.

The SLAR program was conducted in three phases: Phase I, Analysis and Digital Demonstration; Phase II, Competitive Prototyping; and Phase III, Pre-production Prototyping. In FY76 the program was held at the advanced development level because of the need for a substantial amount of additional R&D. Phase II was completed and Phase III was initiated in FY81.

In FY83, elements of a demonstration prototype were integrated into the ground processing system as part of the initial production ground processing and exploitation system specification preparation.

In FY87, the first ASARS-2 production radar was flight-tested and accepted. The Tactical Reconnaissance Exploitation Demonstration System (TREDS) achieved limited operational capability and the TR-1 Ground Station preliminary design review was completed in May. Software development for the ASARS-2 Processing Segment (APS) continued.

The TR-1 Ground Station critical design review was conducted in FY88. APS software development continued, as did a variety of capability and technical improvements for the system. In 1992, the aircraft was redesigned the U-2R.

APS training and integration support was to be completed in FY91, along with design modifications for ASARS technology. Plans included tailoring SLAR exploitation techniques for ASARS-capable systems. The SLAR tailoring effort continued until FY93. Design specifications for classified capabilities are yet to be published.

In 1990, TR-1 aircraft were deployed to Cyprus to support Operation Desert Storm. The aircraft were used for a variety of missions, including the search for SCUD missile launch sites and location of Iraqi forces. TR-1s were involved in battlefield surveillance from early on, flying over 300 missions through the end of Operation Desert Storm. Missions changed from several sorties daily in the beginning to 24-hour operations in the latter stages of the operations. Reports indicate that some of the TR-1s flown had not been updated to the full ASARS-2 configuration.

Reports are that TR-1s provided 90 percent of the target information received by the Army. ASARS-2 played a major role in planning and conducting breaching operations during the ground war. The radar could map barriers and report on Iraqi positioning, making it possible for the Coalition forces to go around instead of through many of Saddam Hussein's forces. The fixed-target detection capabilities of the ASARS radar complemented the moving-target performance of JSTARS. Operations frequently involved using the TR-1's radar to check and verify suspected targets, mapping battlefield obstacles, and tracking Iraqi force deployment/movement.

The data were very useful for targeting. Evaluators claim 11 to 15 SCUD launcher kills could be credited to JSTARS/ASARS/F-15E hunter/killer teams. Air Force controllers operating from Army ground stations passed search requests to the TR-1 and target information to attack aircraft which locked on to the targets with their own radars. An estimated 80 percent of the targets were found at the exact coordinates indicated.

After-action reports indicated that intelligence information from a variety of sources was plentiful. The major bottleneck was getting the information distributed around the battlefield to commanders who needed it. General Schwarzkopf, testifying before Congress, was especially critical of this. He pointed out that Coalition forces had a lot of very good information, but could not get it to the commanders who needed it.

In 1996, the high-altitude aircraft were considered for deployment to support the Operation Joint Endeavor mission in Bosnia. Aircraft were deployed from the Royal

Air Force Base at Fairford, England, to Istres le Tube, France to facilitate mission operations. Deploying up to five aircraft was planned. The idea was to deploy aircraft with the new MTI capability to help JSTARS monitor ground movements among the opposing forces. The high altitude of the U-2R would make it possible to see into some of the valleys that were shielded from the JSTARS radar. The end of hostilities limited the tactical usefulness of the move.

Production of the new COTS processor upgrade for all ASARS-2 ground stations was contracted in August 1994. Factory acceptance testing took place in May 1995. Environmental testing of a ruggedized airborne version was completed successfully in January 1995.

A prototype airborne version of the new processor was delivered to the Air Force for testing in 1995. The 95 pound system uses software that is common with the ground processor. The advanced capabilities would make it possible to have an MTI capability on board the aircraft instead of having to transmit radar to the ground station for MTI processing.

During the Roving Sands exercise in April 1997, an upgraded version of the U-2 SAR was considered an unqualified success. According to reports, radar imagery was credited with three kills and one re-tasking against Scud-type targets in just over four minutes. The radar worked with F-15E attack aircraft in the exercise.

Funding

Recent funding is from platform and O&M accounts. Congress added US$15 million to the FY95 budget for the Enhanced MTI development. In FY97, Congress added US$ 57 million to the US$28.3 million request for U-2R sensor upgrades. In the FY98 Appropriation, the Senate added some funding for various U-2-related lines; but these were dropped in conference.

Recent Contracts

(Contracts over US$ 5 million.)

Contractor	Award ($ millions)	Date/Description
Westinghouse	4.7	Feb 1996 – Increment as part of a US$6,585,008 CPFF letter contract to support ARPA Advanced Concept Technology Demonstration (ACTD) activity and satisfy a critical DoD need. The Semi-Automated Image Intelligence (IMINT) processing system is a DoD initiative to develop and field a set of integrated exploitation tools for the U-2R aircraft. To be completed November 1997. (MDA972-96-3-0005)

Timetable

Aug	1955	First U-2 flight
	1972	Development of ASARS initiated
	1977	Contract awarded to Hughes for SLAR development
Aug	1981	First TR-1 flight
Sep	1981	First TR-1 delivered
	1984	ASARS deployed
Jul	1985	First ASARS-2 operational sortie
Jun	1986	ASARS-2 entered flight testing
	1988	Ground station CDR
Oct	1989	Last U-2R delivered
	1992	TR-1 re-designated U-2R
Mar	1994	CBSP IOC
Aug	1994	CBSP contract awarded
Jan	1995	CBSP airborne environmental tests complete

Mar	1995	Enhanced MTI software development award
	2035	U-2R retirement

Worldwide Distribution

US Air Force only.

Forecast Rationale

During Operation Desert Storm, the Air Force used the TR-1 (now the U-2R) to provide theater coverage and intelligence-gathering. Operating from beyond the reach of most threats, the ASARS-2 radar provided target location information under conditions in which non-radar and other sensors were ineffective. Aircraft equipped with ASARS-2 can look approximately 55 kilometers (35 miles) into hostile territory.

The advanced synthetic aperture radar performs well and features some of the most recent technology and software available. Operation Desert Storm and other operations proved this in actual combat. Although two SR-71s were temporarily pulled out of retirement, the U-2R is the only major platform for specialized battlefield surveillance. By combining with JSTARS, the U-2R/TR-1 proved its value as part of an overall battlefield surveillance system that combines high- and low-altitude surveillance with reconnaissance capabilities. Contingency operations and disaster support will be the main mission for the U-2R.

The ASARS-2 capabilities were recognized in the DoD's desire to deploy EMTI-equipped U-2Rs to Operation Joint Endeavor to aid JSTARS. The high operational altitude of the aircraft makes it possible to see deep into some of the terrain-caused screening problems for the E-8s. The weakness of the plan was the lack of available modified aircraft.

Continued improvements will perfect processing software and radar upgrades. The ground station will expand its ability to process and distribute the data provided by the aircraft. The major efforts are the ASARS processing segment software and increasing the imagery yield at extended ranges. Technology developed by this program is being carried into other Hughes airborne radars, such as the APG-73.

The new airborne processor is an important asset for the aircraft. It is lighter and more capable, and reduces the need to data link everything to the ground for processing. This will make MTI operations possible on the aircraft and transmitting processed target data direct to ground commanders possible.

NASA is flying the ER-2, a high-altitude research platform, on a variety of earth-science missions. The aircraft is configured to carry a variety of research packages, including ASARS-2 where needed. The space agency also uses SR-71 Blackbirds for special research projects. Some of these missions could call for the radar as well.

Further production of the airborne radar for U-2Rs has been considered unlikely, although the airborne processors are being replaced and the radars enhanced. New, more powerful and fuel efficient engines are being installed in the aircraft. Logistics support will continue, along with software and hardware upgrades.

There has been talk about the United Kingdom considering U-2s to meet some of its reconnaissance needs. This could result in a re-opening of the production line to support a UK procurement, should it come about. If the line is reopened, the US may become interested in buying a few more aircraft to replace heavily used aircraft. This could result in a small radar production run.

Raytheon is reportedly offering a dual-mode ASARS-2 mounted on a Bombardier Global Express to meet the UK ASTOR requirement as well. Other radars, including JSTARS, are competing for the program. A procurement decision is expected in 1998. The outcome is not considered certain enough to predict a new ASARS-2 production run at this time.

Programs to develop a crewless, loitering, high-altitude reconnaissance aircraft may eventually call for the production of an ASARS follow-on. Several companies, including Hughes with its HISAR, are following the program closely.

Ten-Year Outlook

No further radar production planned, although the ASARS-2 is being considered for the UK ASTOR surveillance system program.

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