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The new ADS-B based aircraft avoidance system at the MLRO

D. Iacovone (1), G. Bianco (2)
(1) e-Geos S.p.A., ASI/CGS – Matera (Italy)
(2) Agenzia Spaziale Italiana, CGS – Matera (Italy)

Contact : (1) domenico.iacovone@e-geos.it
(2) giuseppe.bianco@asi.it

Abstract. *The Matera Laser Ranging Observatory (MLRO), since the beginning of operations, has been equipped with a pulsed radar system which stops the ranging activity in case of possible collision between the laser beam and flying aircrafts. The MLRO safety standards have recently been improved with the integration of a new safety device based on the Automatic Dependent Surveillance – Broadcast (ADS-B) technology, on which the new Air Traffic Management (ATM) standards, to be enforced in Europe from January 2015, will be based. This presentation gives a thorough description of the capability of the new virtual radar system and its integration in the MLRO.*

Introduction.

The aircraft avoidance system of the Matera Laser Ranging Observatory (MLRO) consists of a pulsed radar system which stops the ranging activity in case of possible collision between the laser beam and flying aircrafts. The mentioned system has recently been enriched by the integration of a new safety device based on the Automatic Dependent Surveillance – Broadcast (ADS-B) technology. The main international programs adopting the new technology are:

- NextGen (*Next Generation Air Transportation System*), FAA [1]
- SESAR (Single European Sky ATM Research), Eurocontrol [2]

Eurocontrol decided that all new aircrafts from January 2015 on shall carry a ADS-B based transmitter, while older aircraft shall comply from December 2017.
MLRO's aircraft avoidance system is already equipped with a redundancy in the safety subsystem by means of the integration of a new virtual radar based on the ADS-B technology.

ADS-B technology.

Due to the difficulty in obtaining the position of aircrafts flying far from ground based pulsed radar systems, international air traffic control authorities are supporting the use of *virtual* radar systems with GPS-based technology.
The ADS-B (A*utomatic Dependent Surveillance - Broadcast*) technology allows for a continuous information transmission between aircraft and ground stations.
The advantages of the new technology are [3]:

- Improved safety
    - Info available to pilots as well
    - Increased aircraft range
- New services
    - Meteo info
    - Maps

- Pilots know their position relative to nearby aircraft
- Cheaper ground stations

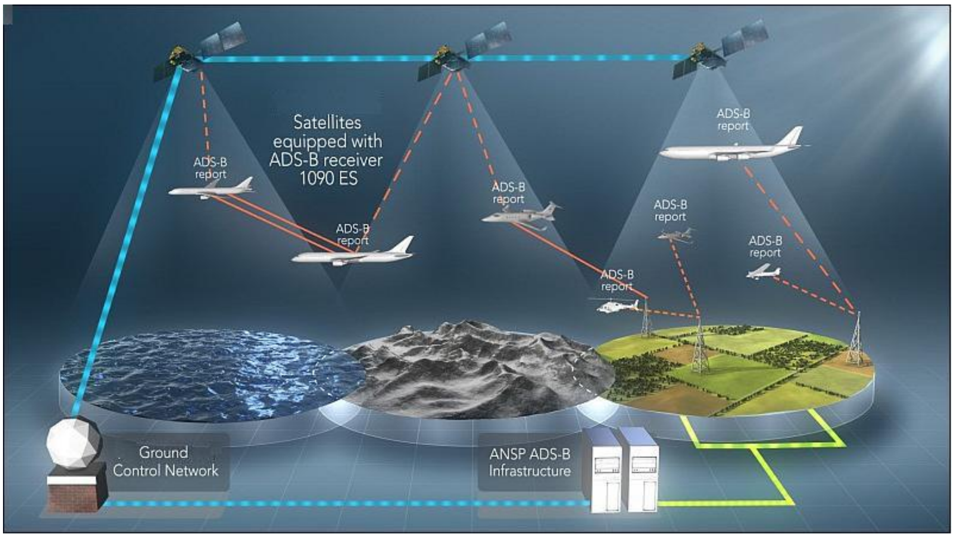

Figure 1. ADS-B technology overview

MLRO case study.

The MLRO’s virtual radar is based on the RadarBox device produced by AirNav Systems, which is a receiver able to decode ”Mode S Extended Squitter” signal transmitted by aircrafts including ADS-B technology (carrier @1090 MHz).

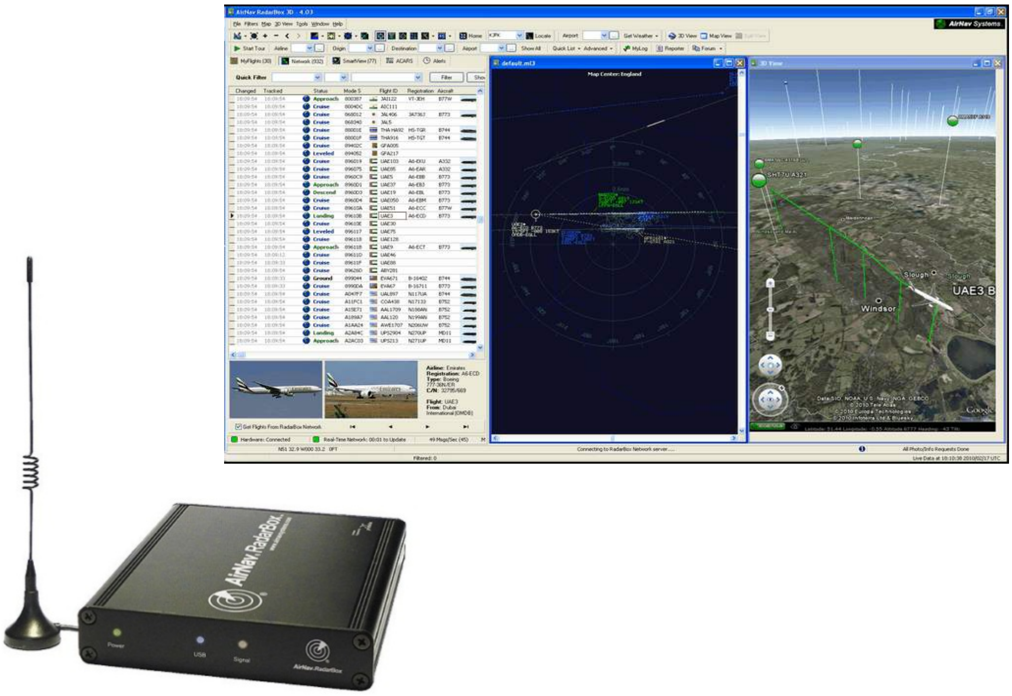

Figure 2. AirNav Radarbox overview

The system includes an antenna and a RF signal amplifier with the following specifications:

Antenna GP-1090		
Specifiche	**Valore**	
Bandwith	1070 -1110 MHz	
Gain	5dB + / - 0.5 dB	
Connector	N-type	
Length	55 cm	
Cable	RG58, 20 mt	
Amplificatore AS-1090		
Specifiche	**Valore**	
Bandwith	1030 -1090 MHz	
Gain	12dB	
NF	0.9 dB	
Power supply	12 VDC	
Current	100 mA	
Max input level	+2dB	
Connector	N-type	
Size	74 x 93 x 45 mm	

Table 1. Antenna GP-1090 and amplifier AS-1090 specifications

Generally the guidelines of the project of an aircraft avoidance system include some considerations about aircraft typical altitudes and velocities [4], so we distinguish two main categories with the following specifications:

Aircraft	Best case	Worst case
Military	$V_{aereo} = 600\ \frac{m}{s}\ @40\ km$ $\omega_{aereo} = 0.86\ {}^{\circ}/_{s}$	$V_{aereo} = 600\ \frac{m}{s}\ @300\ m$ $\omega_{aereo} = 63\ {}^{\circ}/_{s}$
Civilian	$V_{aereo} = 220\ \frac{m}{s}\ @40\ Km$ $\omega_{aereo} = 0.32\ {}^{\circ}/_{s}$	$V_{aereo} = 220\ \frac{m}{s}\ @300\ \mathrm{m}$ $\omega_{aereo} = 36\ {}^{\circ}/_{s}$

Table 2. Aircraft risk scenarios

In case of a low flying aircraft, the RadarBox is not reliable due to the 1s period of its «Mode S» transmission; hence it cannot replace the pulsed radar (750 Hz pulse rate) but only complement it. Before January 2015 any aircraft flying over the MLRO area is not necessarily equipped with such a transmitter so at this time it is not yet possible to get rid of the pulsed radar. Moreover it's possible to distinguish an avoidance area by restricting the virtual radar specifications to the following:

Parameter	Value
Azimuth	$(AZ_{MLRO} - 10°) \leq AZ_{aereo} \leq (AZ_{MLRO} + 10°)$
Elevation	$(EL_{MLRO} - 10°) \leq EL_{aereo} \leq (EL_{MLRO} + 10°)$
Rangemax	40 Km
Latency of aircraft position	5 sec
Latency of MLRO pointing	5 sec

Table 3. MLRO's virtual radar specifications

MLRO's virtual radar architecture.

The MLRO's virtual radar architecture is based on the intercommunication among several systems, because of the need of retrieving and comparing AZ/EL telescope and aircraft coordinates.
In order to reduce latency problems in retrieving data, a TCP/IP protocol intercommunication system has been adopted while a web interface constantly monitors the entire device's operation in case of system failure. The architecture is briefly illustrated in **Figure 2:**

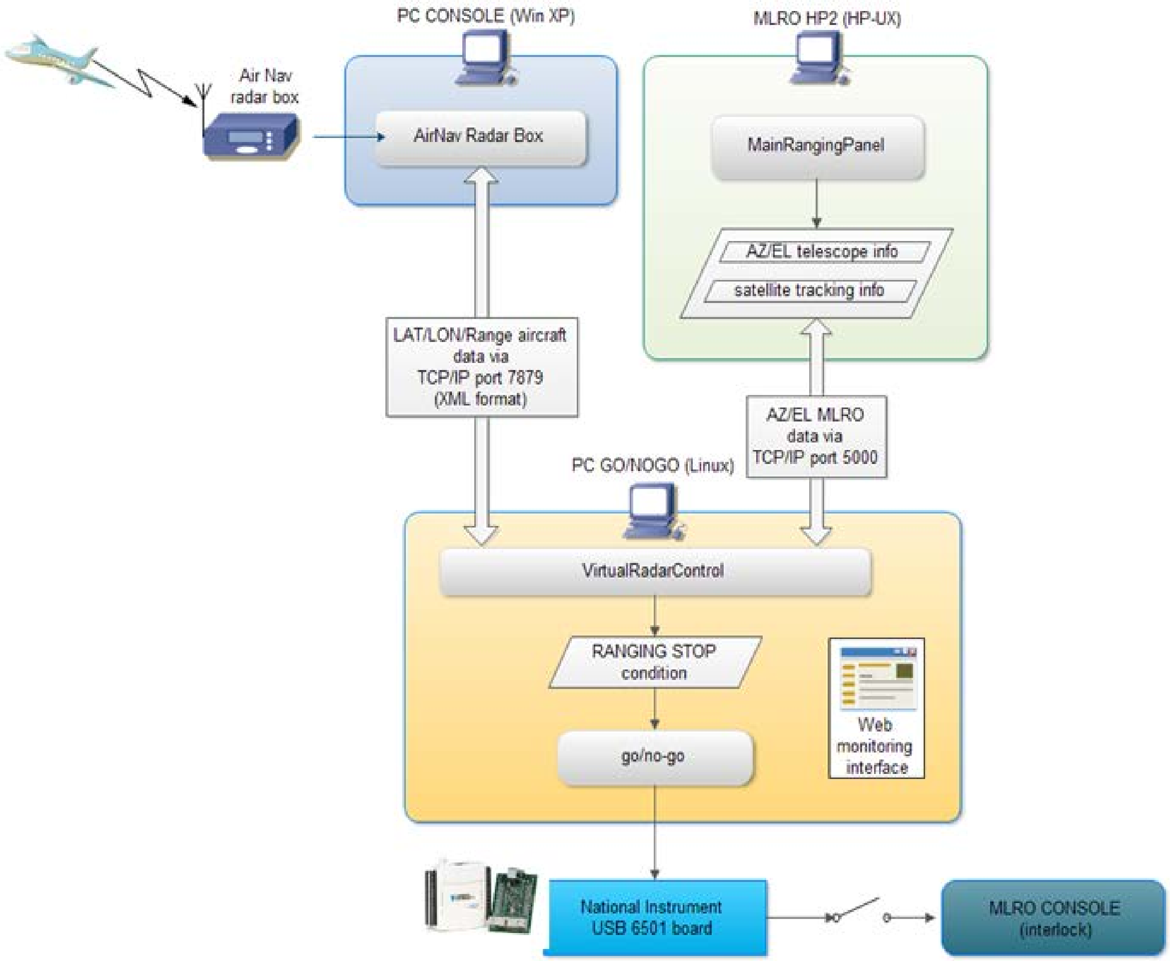

Figure 2. MLRO's virtual radar architecture

Conclusions.

The new ADS-B based aircraft avoidance system has been designed, built and integrated into the MLRO system by e-Geos and it's currently set up as a backup system in case of main radar system failure.

References

[1] *http://www.faa.gov/nextgen/*

[2] *http://www.sesarju.eu/*

[3] *http://www.boeing.com/commercial/aeromagazine/articles/qtr_02_10/pdfs/AERO_Q2-10_article02.pdf* - BOEING Company

[4] *http://www.enac.gov.it/repository/ContentManagement/information/N1311144678/Reg-Regole_Aria_Edizione2_Emdt2.pdf* - ENAC Company, 2007