INTEGRATED AVIONIC SYSTEM SPECIFIC FOR AIR TRAFFIC SAFETY

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Abstract: *Traffic Alert and Collision Avoidance System (TCAS) obtains flight data from the barometrical altimeter on board, directly from the altitude encryption device or from an aerodynamic air data base which contains information regarding: altitude, vertical speed and the altitude of any unknown aircraft which can be considered a foe/enemy. Our suggestion is to have satellites aiding the navigation system in collection of data: position, direction, speed etc.*

Keywords: *TCAS, transponder, adding machine, traffic advisor, resolution advisor*

1. INTRODUCTION

Air traffic is in a continuous expansion, helped by the development of monitoring and control systems, leading to a satisfying flight safety.

Despite the technical advances and pilot training the risk of air collisions still exists, furthermore a series of catastrophes took place in the USA:

- in 1956, the collision of two airplanes above the Grand Canyon ;
- in 1978, the collision between a light airplane and commercial airliner above San Diego;
- in1986, the collision between a DC-9 and a private jet in Cerritos.

The catastrophe from 1978 was the premises for the initiation and development of **TCAS** (Traffic Alert and Collision Avoidance System).

TCAS is radio electronic equipment which functions on the second principle of radiolocation, communication between two or more airships found in a possible traffic conflict, with the help of widgets named transponders (with the condition that the transponders are activated and configured properly).

2. THE OPERATIONAL PRINCIPAL BEHIND THE COLLISION AVOIDANCE SYSTEM

Along with TCAS the ICAO organisation (International Civil Aviation Organisation) has been developing, starting with the 80s, standards for ACAS (Airborne Collision Avoidance Systems) [1].

ACAS is programed to think independently of the on board navigation system as well as of the ground systems used for carrying out air traffic services. The signature component specific for ACAS (proposed by Dr. John S. Morell in 1955), does not function on the elemental distance but on the elemental time. After a set of replies, ACAS basically calculates the time in order to limit CPA (Closest Point of Approach) , making a ration between distance and speed approach [1].

If the intruder transmits his altitude, ACAS will calculate the precise time when the airships will reach the same altitude.

Referring to these systems (since 2009) only TCAS is in accordance with the ACAS standards of ICAO, more specifically TCAS II v7.0 (produced by Rockwell Collins, Honeywell and ACSS) .

TCAS III was scheduled to present the new generation in collision avoidance equipment [2,3] .

TCAS III was an update for TCAS II, and could fix traffic situations using manoeuvres even on a horizontal plan, which would increase the distance between airships.

Civil airships carrying a turbine motor and with a capacity over 30 people, flying in USA air space must be equipped with TCAS II.

Since 1993 the number of long flight airships equipped with TCAS II grew, even though in EUROPE this equipment was not mandatory

Studies and evaluations over time showed an increase in safety offered by TCAS II. In 1995, EUROCONTROL *Committee of Management* approved a implementation policy and a program for the mandatory use of ACAS II in Europa.

This was ratified by the *European Air Traffic Control Harmonisation and Integration Programme* (EATCHIP) [4].

The working principal of CAS (Collision Avoidance System) is predictable and is being developed in two different directions: sensitivity and warning signalling.

Sensitivity is reported to altitude and represents the level of protection. Signalling time is centred on time till CPA (Closest Point of Approach).

Signalling time also includes supplementary protection in distance for close range calls. TCAS obtains flight data from the barometrical altimeter on board, directly from the altitude encryption device or from an aerodynamic air data base which contains information regarding: altitude, vertical speed and the altitude of any unknown aircraft which can be considered a foe/enemy.

When the airship is below 1700 feet, TCAS's algorithm calculates the position of the intruder ship using the on board barometrical altitude and radio altimeter as well as the barometrical altitude of the intruder ship.

If the now dangerous airship is below 380 feet the TCAS will consider it on ground (fig.1).

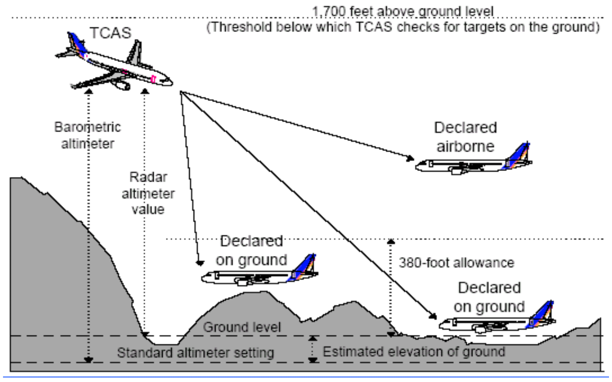

Fig.1 Target on-the-ground determination [Eurocontrol – ACAS II Training Brochure]

3. THE STRUCTURE OF THE COLLISION AVOIDANCE SYSTEM AND THE PROPOSED MODEL

After the presented models the TCAS has the components: (fig.2) :

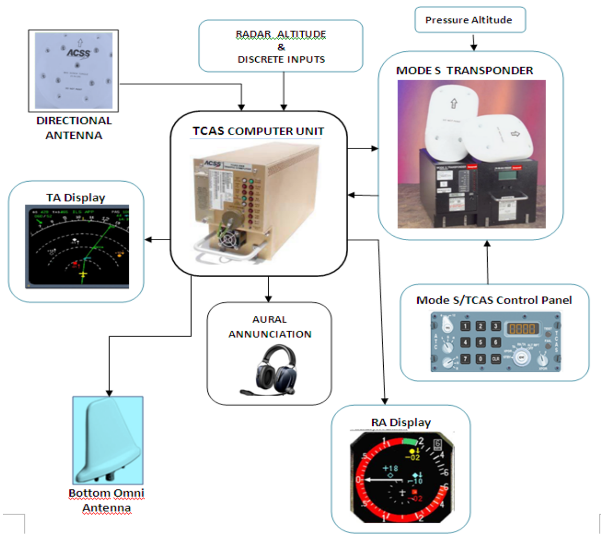

Fig. 2 Simplified block scheme of the TCAS system

- a computer
- TCAS control panel
- Two antennas – one mounted in upper side of the fuselage and the second in the lower part.
- Connection with a transponder S mode ;
- Connection with the altimeter – to obtain the barometrical altitude; or ADC (Air Data Computer) if equipped;

- Connection with the radar altimeter – to restrict the radar altimeter when close to the ground and to see if the followed ship is on the ground;
- Audio systems – acoustical awareness;
- Display – to display the information.

The awareness signal systems emanated by ACAS depends on the mode in which the transponder is programmed during a conflict flight [3,4]:

- lack of awareness signal if the transponder is not functional, broken or not synchronized with the ICAO standards;
- TA (Traffic Advisory), in order to warn the pilot for foe visual identification;
- RA (Resolution Advisory), are manoeuvres indicated to the pilots, only if the transponder reports the altitude.

To determine the distance and altitude, the airship identifies itself in a Cartesian coordinate system.

$$(s_n)_t=[(s_n)_{x,t};(s_n)_{y,t};(s)_{a,t}]^T \quad (1)$$

3D position equation for the airship n and

$$(w_n)_t = [(w_n)_{x,t};(w_n)_{y,t};(w)_{a,t}]^T \quad (2)$$

the 3D express of the speeds, where *x, y* represent the horizontal system of the axes and a represents the altitude. Our proposal implies that the coordinates of the airship should be determinate with the help of satellites, thus eliminating the possibility of errors.

A scheme of the proposed system could be presented in the next form:

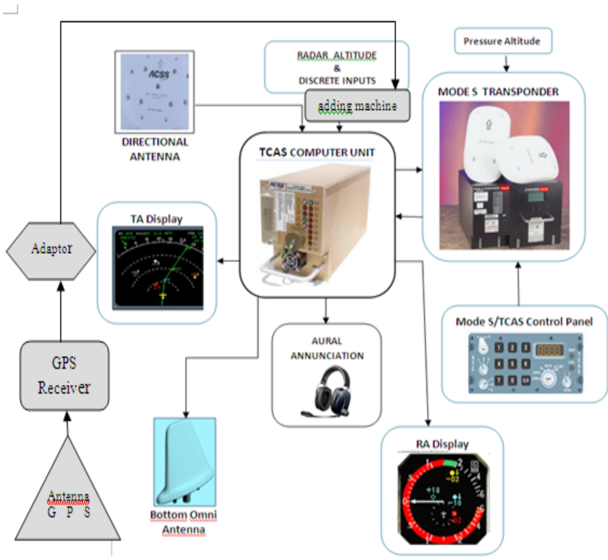

Fig.3 Simplified block scheme of the TCAS system with a GPS system

Position signals, speeds, trajectory directions for each airship are taken over and processed the following command line: Antenna-GPS receptor – Adaptor, applied to a device where the errors referring to the barometrical altimeter could be valuable.

4. CONCLUSIONS & ACKNOWLEDGMENT

Over time there have been concerns referring to the TCAS system's opportunity.

It has been hypothesized that airships equipped with TCAS might trigger a domino effect.

The appearance of circumstance refers to the vertical movement of two airships as a result of the RAs emitted by TCAS would trigger a conflict with a third forcing it to deviate from its course and propagating the domino effect.

The introduction of an additional channel, this being our proposal the correction through GPS with the possibility of informing the airships in the possible danger zone and future navigating intentions, we could significantly reduce both collisions and their premises.

BIBLIOGRAPHY

1. ICAO-*Airborne Collision Avoidance System (ACAS) Manual* First Edition — 2006

2. Annex 10 of ICAO - Aeronautical Telecommunications - Volume IV – "*Surveillance Radar and Collision Avoidance Systems*"

3. Doc. 4444 of ICAO - PANS-RAC – "Procedures for Air Navigation Services – *Rules of the Air and Air Traffic Services*"

4. RTCA SC-147 / DO-185A - Minimum Operational Performance Standards for Traffic Alert and Collision Avoidance System (TCAS) Airborne Equipment