Terrain Awareness and Warning Systems operations based on GPS data

Dimitri CARSTENSEN
Surveillance Systems Engineer

1 Introduction

The following article is giving comprehensive information on the Airbus policy promoting the use of GPS data for TAWS operations. This subject was introduced for the first time in Safety First #1 (January 2005) through the article titled "*Go-Arounds at Addis Ababa due to VOR Reception Problems*".

The two TAWS systems proposed by Airbus, EGPWS and T²CAS, were originally coupled to the Flight Management computer to gather aircraft position and navigation data. The FM system is using data originating from multiple sources (GPS, IR from ADIRU, Navaids such as VOR, DME, …) to compute the aircraft position.

Experience has shown that FM and ADIRU data could be affected by improper IR alignments, erroneous Navaids or improper ADR barometric settings. These could lead to TAWS spurious alerts and unnecessary go-around procedures during approach and landing phases.

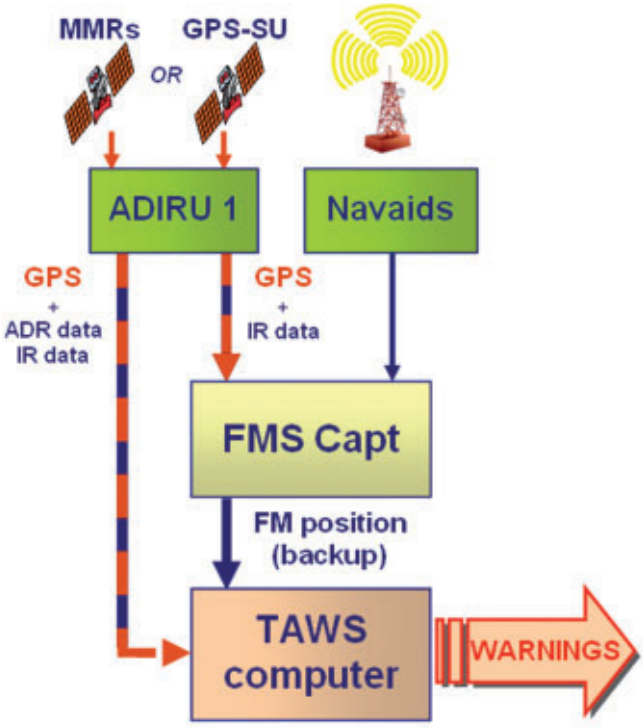
Consequently, Airbus developed new TAWS architectures where the TAWS computer takes the aircraft position data directly from the GPS sensor.

2 Basic principles of the new TAWS + GPS architecture :

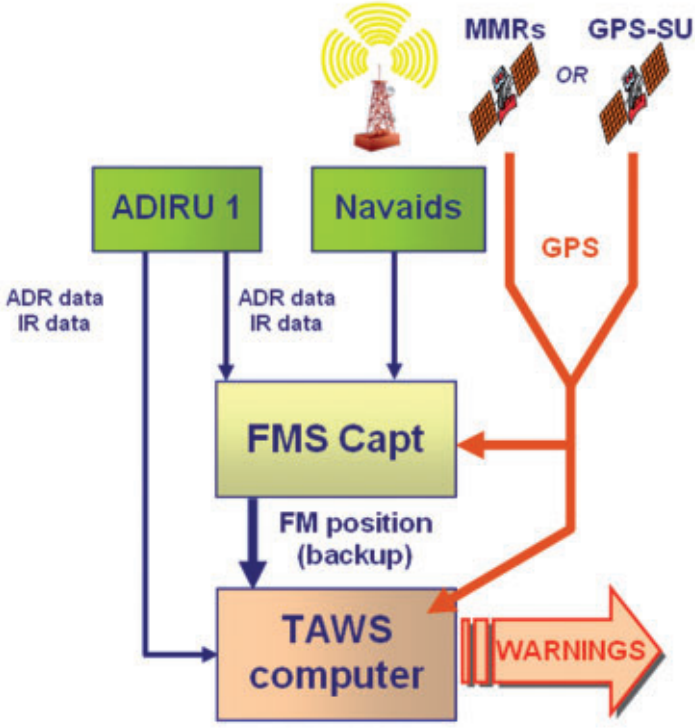
The new TAWS architecture is based on the use of a GPS sensor (Multi Mode Receiver or GPS Stand-alone Unit) linked to the TAWS computer.

Indeed, with this GPS based architecture, TAWS performance is improved due to the better accuracy of GPS information compared to FM and ADIRU data. The segregation of the surveillance aircraft positioning data channel from the navigation channel ensures a full independence between these two major avionics functions.

The GPS is linked either directly (Autonomous configuration -) or through the ADIRU 1 (Hybrid configuration – most common on Airbus aircraft). In the latter configuration The ADIRU 1 is not interacting on the GPS data delivered to the TAWS computer, it is only used as a pass-through media.



Hybrid architecture
Most commonly used on Airbus (ADIRU 4MCU)



Autonomous Architecture
Previously used on Airbus (ADIRU 10MCU)

The TAWS computer uses the GPS data for positioning the aircraft in the three dimensions:

- The latitude and longitude data are used to position the aircraft relative to the TAWS Terrain Database (EGPWS and T²CAS).
  This can be easily implemented on the aircraft by activating the corresponding functions on the TAWS computers by simple pin programming. These functions are named "Use of GPS for Lateral positioning" on EGPWS, and "Alternate Lateral Position based on GPS" for T²CAS.

- The altitude data is used to compute a "Geometric Altitude" (EGPWS) also called "Alternate Vertical position based on GPS" (T²CAS), which is a blend of the Barometric altitude, Radio Altitude, terrain and runway elevation data to ensure optimal performance of the Basic and Terrain functions of the TAWS computer.

  As above, these functions can be easily activated on aircraft by a simple pin programming of the TAWS computer.

In addition, when GPS data are used for latitude and longitude, the TAWS computer is modified by pin programming to perform an automatic management of the Terrain functions. This management is based on the availability and precision of the different position sources (by order of priority: GPS, IR from ADIRU, FM Computer).

When these position sources are neither available, nor precise enough, the TAWS computer automatically deactivates its Terrain functions. Previous deactivation had to be performed manually with the possible consequence, in case of omission, of potential spurious Terrain warnings during the approach and landing phases.

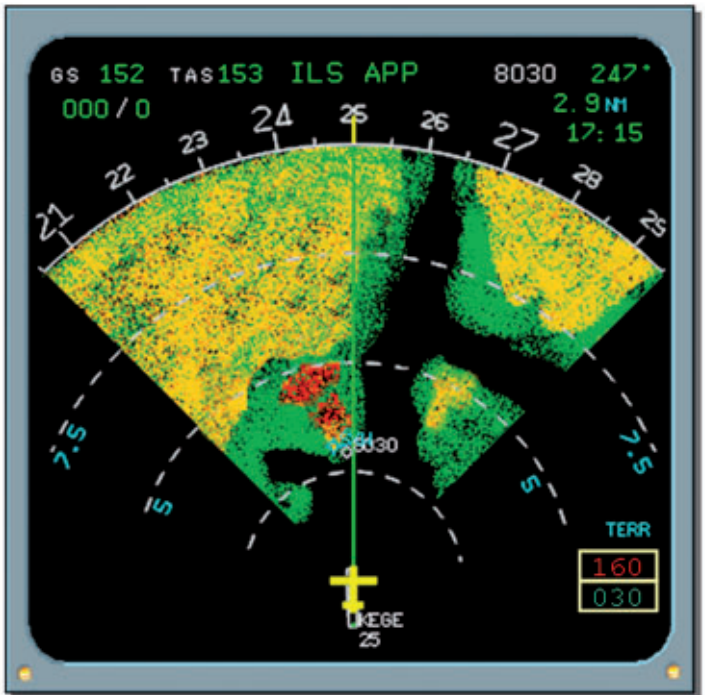
Note: In case of the Terrain function deactivation, basic TAWS Reactive Modes 1 to 5 remain fully operative.

3 | Implementation for the EGPWS | Computer (Honeywell) :

Airbus has certified the new Honeywell EGPWS P/N 965-1676-002 for the direct use of GPS data, either in Hybrid or Autonomous configuration.
The EGPWS P/N 965-1676-002 can be installed in place of previous EGPWS versions, on all Airbus aircraft.

In addition to the use of GPS data for latitude/ longitude positioning and activation of the geometric altitude, P/N 965-1676-002 also provides the availability of Peaks and Obstacles functions for all Airbus aircraft equipped whether with EIS1 (CRT) or EIS2 (LCD) display systems.

The Obstacles function enables the EGPWS to alert the crew of possible collision with man-made obstacles. The Peaks function enables the display of the terrain with the elevation being relative to the Mean Sea Level (MSL).
The green number in the lower right corner of the display features the lowest terrain altitude. The red number, just above, indicates the altitude of the highest obstacle.



Peaks & Obs display

This new EGPWS will enable a fleet wide Part Number commonality whatever the aircraft configuration, resulting in a noticeable operational benefit.

Airbus has developed a set of Standard Service Bulletins for installing EGPWS P/N 965-1676-002 and activating the GPS data based functions. These Standard Service Bulletins are covering every Airbus aircraft and have been sent to every operator having aircraft already equipped with EGPWS P/N 965-0976-003-206-206 or P/N 965-1676-001.
In production, the TAWS + GPS architecture on EGPWS equipped aircraft has been standardized since January 2006.

Please refer to OIT ref. SE 999.0050/06/VHR dated 18 April 2006.
Please refer to SIL 34-080 rev.06 (March 2007).

4 | Implementation for the T²CAS Computer (ACSS)

The “Alternate Lateral Position based on GPS” and “Alternate Vertical position based on GPS” functions can be easily activated through pin programming on T²CAS Standard 1 P/N 900000-10110 and future Standard 2 P/N 900000-11111 (certification obtained in April 07), on every Airbus aircraft.

Airbus has developed a set of Standard Service Bulletins for the activation of these GPS data based functions. These Standard Service Bulletins are covering all Airbus aircraft families and have been sent to all operators using aircraft already equipped with T²CAS Standard 1 P/N 900000-10110.
In production, the TAWS + GPS architecture on T²CAS equipped aircraft has been standardized since May 2005.

Please refer to OIT ref. SE 999.0034/07/VHR Dated 13 March 2007.
Please refer to SIL 34-080 rev.06 (March 2007).

5 | Regular update of the TAWS database

TAWS operations are based on the use of a terrain database. This database must be kept updated regularly to the latest version to obtain the full operational and safety benefits of TAWS operations.

Please refer to SIL 34-080 for more information on the terrain Database and its associated downloading procedure.

6 | Conclusion

Errors in the aircraft position provided by the Flight Management computer to the TAWS system may lead to spurious alerts and unnecessary go-arounds.

Airbus has therefore developed a new system architecture, which links the TAWS computer directly to the GPS. This solution is easy to retrofit and improves the performance of the system.

Please refer to SIL 34-080 rev. 06 (March 2007) to find the applicable Standard Service Bulletins for your aircraft fleet.

For more information about FM map shifts scenarios and root causes analysis, please refer to SIL 22-043.

The Airbus Policy promoting this new TAWS system architecture based on GPS data is given in OIT/FOT ref. SEE999.0015/04/VHR dated 05 Feb 2004.

Safety First

The Airbus Safety Magazine
For the enhancement of safe flight through
increased knowledge and communications.

Safety First is published by the Flight Safety Department of Airbus. It is a source of specialist safety information for the restricted use of flight and ground crew members who fly and maintain Airbus aircraft. It is also distributed to other selected organisations.

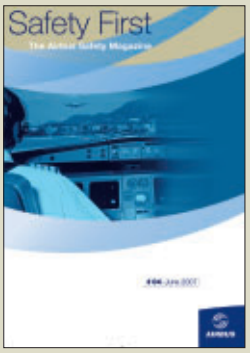
Material for publication is obtained from multiple sources and includes selected information from the Airbus Flight Safety Confidential Reporting System, incident and accident investigation reports, system tests and flight tests. Material is also obtained from sources within the airline industry, studies and reports from government agencies and other aviation sources.

All articles in Safety First are presented for information only and are not intended to replace ICAO guidelines, standards or recommended practices, operator-mandated requirements or technical orders. The contents do not supersede any requirements mandated by the State of Registry of the Operator's aircraft or supersede or amend any Airbus type-specific AFM, AMM, FCOM, MEL documentation or any other approved documentation.

Articles may be reprinted without permission, except where copyright source is indicated, but with acknowledgement to Airbus. Where Airbus is not the author, the contents of the article do not necessarily reflect the views of Airbus, neither do they indicate Company policy.

Contributions, comment and feedback are welcome. For technical reasons the editors may be required to make editorial changes to manuscripts, however every effort will be made to preserve the intended meaning of the original. Enquiries related to this publication should be addressed to:

Airbus
Product Safety department (GS)
1, rond point Maurice Bellonte
31707 Blagnac Cedex - France
Fax: +33(0)5 61 93 44 29
safetycommunication@airbus.com



Safety First
 # 04 June 2007

Safety First is published by Airbus S.A.S
1, rond point Maurice Bellonte
31707 Blagnac Cedex / France

Editors:
Yannick Malinge,
Vice President Flight Safety
Christopher Courtenay,
Director of Flight Safety

Concept Design by
HCSGM 20070592
Production by Quat'coul

Copyright: GSE

Photos copyright Airbus
Photos by ExM:
Hervé Berenger
Philippe Masclet
Hervé Goussé

Printed in France