International Civil Aviation Organization

EIGHTEENTH MEETING OF THE COMMUNICATIONS/NAVIGATION AND SURVEILLANCE SUG-GROUP (CNS SG/18) OF APANPIRG

Asia and Pacific Regional Sub-Office, Beijing, China
(21 – 25 July 2014)

Agenda Item 7.2: **Surveillance: Discuss other surveillance related issues**

ENHANCING AVIATION SAFETY THROUGH ESTABLISHMENT OF A REGIONAL ADS-B AVIONICS PROBLEM REPORTING DATABASE (APRD)

(Presented by Hong Kong China)

SUMMARY

Since December 2013 when ADS-B mandate for some major traffic flows in certain airspace over the South China Sea became effective, monitoring and analysis on avionics performance of ADS-B equipped aircraft has become an increasingly significant task for concerned States/Administrations. In the recent ADS-B SITF/13 meeting, Hong Kong China presented a joint working paper with Australia and Singapore outlining a proposal to establish a centralized database at the ICAO Regional Sub-office (RSO) for sharing the monitoring results to enhance aviation safety for the Region. The proposal has gained support and endorsement from the ADS-B SITF/13 meeting. This paper outlines the latest progress in development of the database, and calls for support from CNS SG on continuous development of the database through collaboration with concerned States and ICAO RSO.

1. INTRODUCTION

1.1 During past ADS-B SITF and SEA/BOB ADS-B WG meetings, Australia, Hong Kong China and Singapore have presented working papers highlighting work undertaken to monitor and analyse avionics performance of ADS-B equipped aircraft. In the recent ADS-B SITF/13 meeting, Hong Kong China presented a joint working paper with Australia and Singapore outlining a proposal to establish a centralized database at the ICAO Regional Sub-office (RSO) for sharing the monitoring results to enhance aviation safety for the Region. The proposal has gained support and endorsement from the meeting. Since then, Hong Kong China, Australia and Singapore have been working with the RSO to develop detailed requirements and specification for the database together with access and security procedures for provision and sharing of data. This paper highlights the latest progress in development of the database.

2. DISCUSSION

2.1 Since December 2013 when ADS-B mandate for some major traffic flows in certain airspace over the South China Sea became effective, monitoring and analysis on avionics performance of ADS-B equipped aircraft has become an increasingly important task for concerned States/Administrations. Problems detected/observed from the monitoring could have safety implications to ATC, which require timely promulgation and rectification by airline operators. In

order to effectively manage, track and promulgate the problems, a centralized database to be hosted by the ICAO RSO is considered beneficial to the enhancement of aviation safety for the Region.

2.2   Problem Categorization

For ADS-B avionics, their problems are quite diversified in the Region but can be categorized to ensure they will be examined and tackled systematically. Based on the experience gained from States, the common ADS-B avionics problems in the Region are summarized under different categories as shown in Appendix 3. It is noted that only a relatively minor portion of the aircraft population exhibits these problems.

2.3   Database Content and Format

2.3.1   A database termed as the "ADS-B Avionics Problem Reporting Database" (APRD) is proposed to be established for the Region with data fields and formats stipulated in Appendix 1. The database contains information describing different types of avionics problem collectively known to the Region. During the ADS-B SITF/13 meeting, concern was raised regarding identification of operators and individual aircraft in the database accessible to the stakeholders which might potentially lead to "blacklisting" the airframes. Considering that other databases established for the Region with similar purpose (e.g. the database for FANS 1/A Central Reporting Agency) do not disclose the identity of concerned airlines/aircraft, it was proposed and endorsed by the meeting that a database of known generic ADS-B avionics problems without disclosing the identity of airlines/airframes would be established and maintained

2.3.2   The APRD has mandatory fields which must be provided in order to allow the problem to be shared meaningfully, as well as desirable fields which are useful for subsequent follow-up, diagnosis and rectification of the problem. However, since desirable data might not be always available at the time of problem being detected/observed, lack of these data shall not prevent the problem from being timely reported and shared.

2.4   Access and Security Procedures

The APRD will be posted on a secured web-site accessible to States/Administrations. States/Administrations wishing to gain access to the APRD should nominate a single point of contact for registration with the ICAO. The contact person will receive notification from the ICAO when the APRD is updated. Each registered State/Administration will be granted "read" access rights to the APRD with corresponding username and password for login. Administrative rights to the APRD will be limited to the ICAO and States/Administrations with capabilities in monitoring/analysis of ADS-B avionics performance in order to verify correctness of the data.

2.5   Submission and Processing of Problem Reports

2.5.1   State/Administration is encouraged to establish mechanism within its air traffic services provider and regulatory authority to perform monitoring/analysis of ADS-B equipped aircraft. A useful guideline in establishing such mechanism is given in the "ADS-B Implementation and Operations   Guidance   Document   (AIGD)"   posted   on   the   ICAO   web-site "http://www.icao.int/APAC/Documents/edocs/cns/ADSB_AIGD6.pdf".   State/Administration   is encouraged to base on their monitoring results to submit problem reports to the ICAO. A template for submitting problem reports to the ICAO is given at Appendix 2.

2.5.2   When the problem report with initial analysis and recommendation is received from State/Administration, the ICAO will promulgate the problem, with a status of pending verification, through the database as soon as possible, and in parallel forward the problem to those States/Administrations with capabilities in monitoring/analysis of ADS-B avionics performance, for their study and verification. Besides, a forum can be created at the ICAO Portal to facilitate States/Administrations to share their views on the reported problems. The reported problems and views can be deliberated during the ADS-B working group / task force meetings, and the ICAO will work with relevant States/Administrations to update the status in the database accordingly. The identity of the organization submitting the reports will not be disclosed, so as to encourage more States/Administrations to make contribution to the database.

2.5.3   Despite the parties reporting the problem are not shown in the database, the ICAO should keep records of the reporting parties and regularly request the parties to update the status so as to ensure the database is correct and up-to-date.

2.6   Information Retrieval and Exporting

The web-site will provide a Human Machine Interface (HMI) to facilitate information retrieval based on pre-defined searching criteria. For example, it can generate a list of known problems with plans for rectification, etc. All the retrieved information can be exported to EXCEL format (e.g. CSV) for printing and reporting.

2.7   Exchange of Monitoring Results

The database contains useful information as to the generic ADS-B avionics problem commonly encountered in the Region. States are encouraged to make use of the database to report and share problems with others, keep abreast of the latest reported problems, and exchange among themselves the lists of airframes exhibiting the problems for taking remedial action.

3.   ACTION BY THE MEETING

3.1   The meeting is invited to:

   a)   note the latest progress in development of the APRD; and

   b)   support continuous development and operation of the database by the ICAO RSO to enhance aviation safety of the Region.

— — — — — — — — — — — —

Appendix 1 : Content and Format of the
ADS-B Avionics Problems Reporting Database (APRD)

Mandatory Information
These fields must be provided in order to allow the data to be shared.

Desirable Information
These data are useful and desirable to be provided. However, as the data might not be always available at the time of problem being detected / observed, lack of these data shall not prevent the problem from being timely reported and shared.

Table 1 – Problem Type

Field	Description	Mandatory (M) or Desirable (D)
Problem Type	A unique identification number to specify a type of generic problem	M
Problem Description	A detailed description of this type of generic problem	M
Cause	A detailed description of cause(s) of this problem	D
Safety Implication to ATC	Whether the problem will cause any safety implication to ATC	D
Recommendation	Recommendations to tackle the problem	D
Organisation*	The name of organisation reporting the problem	M
Confirmed	Indication that whether the problem has been verified by the verifier (Yes / No)	M
Verifier	The name of organization verified the problem	D
Verifier comments	Comments by the verifier	D
ADS-B Transponder	Description on transponder manufacturer, parts number, software version as appropriate	D
Transponder Message Format	DO260, DO260A or DO260B	D
GNSS Receiver	GNSS manufacturer, parts number, software version as appropriate	D
Position Integrity	Description of NUC or NIC when problem is detected	D
Aircraft OEM Response	Response and/or rectification plans of Airframe Manufacturer when advised of problem	D
Avionics OEM Response	Response and/or rectification plans of Avionics Manufacturer when advised of problem	D
Problem Fixed	Indication that whether the problem has been rectified (Yes / No)	D
Rectification Date	UTC date when the problem was rectified	D

Field	Description	Mandatory (M) or Desirable (D)
Ground Station Manufacturer	Ground Station Manufacturer, model number and software version as appropriate (sometimes it is difficult to determine if the problem is airborne equipment or ground station equipment)	D
Supplementary Information	Attachments such as graphs and pdf documents etc. to a database entry	D

Note : Data fields marked with asterisk (*) mean the data will only be accessible by the Database Administrator, and will not be shared in order to protect identity of the originator of the problem report.

Table 2 - Format of the ADS-B Avionics Problems Reporting Database (APRD)

Field	Type	Size	Remark
Problem Type	Number	4 digits	1 - 9999
Problem Description	Free Text	5,000 chars	Free text to be entered to illustrate the problem
Cause	Free	5000 chars	Free text to be entered to illustrate cause(s) to the problem
Safety Implication to ATC	Free	5000 chars	"Y" or "N" for Yes or No, followed by free text to be entered to explain the reasons why it cause / does not cause safety implication to ATC
Recommendation	Free	5000 chars	Free text to be entered to recommend remedial actions to tackle the problem
Organization	Free Text	200 chars	Name of the organization to which the originator belongs
Confirmed	Text	1 char	"Y" or "N" for Yes or No
Verifier	Free Text	200 chars	Name of the verifier on the problem
Verifier comments	Free Text	5,000 chars	Free text to be entered for verifier's comment
ADS-B Transponder	Free Text	5,000 chars	Free text to be entered on transponder manufacturer, parts number, software version as appropriate
Transponder Message Format	Text	6 char	DO260, DO260A or DO260B
GNSS Receiver	Free Text	5,000 chars	Free text to be entered on GNSS manufacturer, model number and software version as appropriate
Position Integrity	Free Text	200 chars	Free Text to be entered to describe the NUC or NIC value when the problem is detected
Aircraft OEM Response	Free Text	5,000 chars	Free text to be entered to illustrate the response and/or rectification plans of Aircraft Manufacturer

Field	Type	Size	Remark
Avionics OEM Response	Free Text	5,000 chars	Free text to be entered to illustrate the response and/or rectification plans of Avionics Manufacturer
Problem Fixed	Text	1 char	"Y" or "N" for Yes or No
Rectification Date	Date	10 chars	Format : dd.mm.yyyy
Ground Station Manufacturer	Free Text	5,000 chars	Free text to be entered on ground station manufacturer, model number and software version as appropriate
Supplementary Information	N/A	N/A	Attachments such as diagrams, photos, screen shots, graphs and pdf documents etc. to illustrate the problem, cause, remedial actions etc.

Appendix 2 : ADS-B Avionics Problem Reporting Form

ADS-B Avionics Problem Reporting Form	Problem Type : (To be filled by ICAO)

Section 1: (To be filled by reporting organization)

* Problem Description

This should provide as complete a description of the situation leading up to the problem as is possible. Where the organization reporting the problem may not be able to provide all the information (e.g. the controller may not know everything that happened on the aircraft), it would be helpful if they would coordinate with concerned parties to provide the requested information :

- A complete description of the problem being reported
- The route contained in the FMS and/or flight plan
- Any flight deck indications
- Any indications provided to the controller when the problem occurred
- Any additional information that the originator of the problem report considers might be helpful but is not included on the list above
- Diagrams and other additional information (such as printouts of message logs) may be appended to illustrate the reported problem if considered useful.

Cause
Describe cause(s) to the problem

Recommendation
Describe recommendation to tackle the problem

*Organization :	Name of the organization to which the originator belongs
Safety Implication to ATC :	Yes or No, followed by explanation on reasons why it cause / does not cause safety implication to ATC
ADS-B Transponder :	transponder manufacturer, parts number, software version as appropriate
Transponder Message Format :	DO260, DO260A or DO260B
GNSS Receiver :	GNSS manufacturer, model number and software version as appropriate
Position Integrity :	Describe the NUC or NIC value when the problem is detected
Ground Station Manufacturer :	Ground station manufacturer, model number and software version as appropriate

Aircraft OEM Response:	Describe the response and/or rectification plans of Aircraft Manufacturer
Avionics OEM Response:	Describe the response and/or rectification plans of Avionics Manufacturer
Supplementary Information :	Attachments such as diagrams, photos, screen shots, graphs and pdf documents etc. to illustrate the problem, cause, remedial actions etc.
Problem Fixed (Yes/No):	Indicate whether the problem has been fixed or not
Rectification Date:	Date when the problem was fixed
Section 2: (To be filled by Verifier)	
*Confirmed (Yes/No) :	Default is "No". Only change to "Yes" after the verifier has confirmed the reported problem
Verifier:	Name of the verifier on the problem
Verifier Comments:	Views / comments of the verifier regarding problem description, causes, recommendation etc.

Note :
(a) The fields marked with asterisk (*) are mandatory fields required to be filled in.
(b) Please refer to Table 1 in Appendix 1 for detailed description of each field on the Form.

Appendix 3 – List of known ADS-B avionics problems in APAC Region

Ref.	Problem	Cause	Safety Implications to ATC (Yes / No)	Recommendations
1.	Track Jumping problem with Rockwell Collins TPR901 (See Figure1)	Software issue with TPR901 transponder initially only affecting Boeing aircraft. Does not occur in all aircraft with this transponder. Subsequent investigation by Rockwell Collins has found that the particular transponder, common to all of the aircraft where the position jumps had been observed, had an issue when crossing ±180 degrees longitude. On some crossings (10% probability), errors are introduced into the position longitude before encoding. These errors are not self-correcting and can only be removed by a power reset of the transponder. The problem, once triggered can last days, since many transponders are not routinely powered down.	**Yes.** Will present as a few wild/large positional jumps. Nearly all reports are tagged as low quality (NUC=0) and are discarded, however, some occasional non zero reports get through. Problem is very "obvious". Could result in incorrect longitudinal position of Flight Data Record track. Can trigger RAM alerts.	Rockwell Collins has successfully introduced a Service Bulletin that solves the problem in Boeing aircraft. The problem is known to exist on Airbus aircraft. Rockwell has advised that a solution will not be available in the near future because of their commitment to DO260B development. Rockwell Collins may not have a fix for some time. Workaround solutions are being examined by Airbus, Operators and Airservices Australia. The only workaround identified at this time is to power down the transponders before flight to states using ADS-B – after crossing longitude 180. It can be noted that in Airbus aircraft it is not possible to safely power down the transponder in flight. Airbus have prepared a procedure to support power down before flight. Airservices Australia have negotiated with 2 airlines to enact this procedure prior to flights to Australia.

Ref.	Problem	Cause	Safety Implications to ATC (Yes / No)	Recommendations
				An additional partial workaround is : to ensure that procedures exist for ATC to ask the pilot to changeover transponders if the problem is observed. Since there is a 10% chance of the problem occurring on each crossing of ±180 degrees longitude, the chance that both transponders being affected is 1%.
				There is no complete workaround available for flights that operate across 180 degrees longitude directly to destination without replacing the transponder. Airbus advise that a new TPR901 transponder compliant with DO260B will be available in 2014. This new transponder will not exhibit the problem.
2.	Rockwell Collins TDR94 Old version. The pattern of erroneous positional data is very distinctive of the problem. (See Figure 2)	Old software typically before version -108. The design was completed before the ADS-B standards were established and the message definitions are different to the current DO260. Rockwell has recommended that ADS-B be disabled on these models.	**Yes.** Will present as a few wild positional jumps. Nearly all reports are tagged as low quality (NUC=0) and are discarded, however, some occasional non zero reports get through. Also causes incorrect altitude reports. Problem is very "obvious".	Problem well known. Particularly affects Gulfstream aircraft which unfortunately leave the factory with ADS-B enabled from this transponder model. Rockwell has issued a service bulletin recommending that ADS-B be disabled for aircraft with this transponder software. See Service Information Letter 1-05 July 19, 2005. It is easy to disable the

Ref.	Problem	Cause	Safety Implications to ATC (Yes / No)	Recommendations
				transmission. If a new case is discovered, an entry needs to be made to the black list until rectification has been effected.
3.	Litton GPS with proper RAIM processing	Litton GNSSU (GPS) Mark 1 design problem. (Does not apply to Litton Mark II). GPS does not output correct messages to transponder.	**No.** Perceived GPS integrity changes seemingly randomly. With the GPS satellite constellation working properly, the position data is good. However the reported integrity is inconsistent and hence the data is sometimes/often discarded by the ATC system. The effected is perceived extremely poor "coverage". The data is not properly "protected" against erroneous satellite ranging signals – although this cannot be "seen" by ATC unless there is a rare satellite problem.	This GPS is installed in some older, typically Airbus, fleets. Data appears "Correct" but integrity value can vary. Performance under "bad" satellite conditions is a problem. Correction involves replacing the GNSSU (GPS) which is expensive. If a new case is discovered, an entry needs to be made to the black list until rectification has been effected.
4.	SIL programming error for DO260A avionics	Installers of ADS-B avionics using the newer DO260A standard mis program "SIL". a) This problem appears for DO260A transponders, with SIL incorrectly set to 0 or 1 (instead of 2 or 3)	**No.** First report of detection appears good (and is good), all subsequent reports not displayed because the data quality is perceived as "bad" by the ATC system. Operational effect is effectively no ADS-B data. Hence no risk.	Would NOT be included in a "black list". Aircraft with "Dynon avionics" exhibit this behavior. They do not have a certified GPS and hence always set SIL = 0. This is actually correct but hence they do not get treated as ADS-B equipped.

Ref.	Problem	Cause	Safety Implications to ATC (Yes / No)	Recommendations
		b) As the aircraft enters coverage, the ADS-B ground station correctly assumes DO260 until it receives the version number. c) The transmitted NIC (DO260A) is interpreted as a good NUC (DO260) value, because no SIL message has yet been received. The data is presented to ATC.		
5.	Garmin "N" Flight ID problem (See Figure 3)	Installers of Garmin transponder incorrectly set "Callsign"/Flight ID. This is caused by poor human factors and design that assumes that GA aircraft are US registered.	**Yes.** Flight ID appears as "N". Inhibits proper coupling.	Can be corrected by installer manipulation of front panel. Does not warrant "black list" activity.
6.	Flight ID corruption issue 1 – trailing "U" Flight ID's received : GT615, T615U ,NEB033, NEB033U, QF7550, QF7550U, QF7583, QF7583U, QF7585, QF7585, QF7585U, QF7594, QFA7521, QFA7531, QFA7531, QFA7531U, QFA7532, QFA7532U, QFA7532W,	TPR901 software problem interfacing with Flight ID source. Results in constantly changing Flight ID with some reports having an extra "U" character.	**Yes.** Flight ID changes during flight inhibits proper coupling or causes decoupling.	Affects mainly B747 aircraft. Boeing SB is available for Rockwell transponders and B744 aircraft. Rockwell Collins have SB 503 which upgrades faulty -003 transponder to -005 standard. If a new case is discovered, an entry needs to be made to the black list until rectification has been effected.

Ref.	Problem	Cause	Safety Implications to ATC (Yes / No)	Recommendations
	QFA7550, QFA7552, QFA7581			
7.	Flight ID corruption issue 2	ACSS software problem results in constantly changing Flight ID.\n\nApplies to ACSS XS950 transponder Pn 7517800-110006 and Honeywell FMC (pn 4052508 952). ACSS fix was available in Sept 2007.	**Yes.**\n\nFlight ID changes during flight inhibits proper coupling or causes decoupling.	Software upgrade available.\n\nIf a new case is discovered, an entry needs to be made to the black list until rectification has been effected.
8.	No Flight ID transmitted	Various causes	**No.**\n\nFlight ID not available. Inhibits proper coupling.	Aircraft could "fail to couple with Flight Data Record". Not strictly misleading – but could cause controller distraction.
9.	ACSS Transponder 10005/6 without Mod A reports NUC based on HFOM.		**Yes.**\n\nAppears good in all respects until there is a satellite constellation problem (not normally detectable by ground systems).	Not approved and hence not compliant with CASA regulations.\n\nIf known could be added to black list. Configuration is not permitted by regulation.
10.	Occasional small position jump backwards (See Figure 4)	For some older Airbus aircraft, an occasional report may exhibit a small "jump back" of less than 0.1 nm\n\nRoot cause not known	**No.**\n\nNot detectable in ATC due to extrapolation, use of latest data and screen ranges used.	ATC ground system processing can eliminate these.

Ref.	Problem	Cause	Safety Implications to ATC (Yes / No)	Recommendations
11.	Older ACSS transponders report integrity too conservatively	Design error reports integrity one value worse than reality	**No.** In poor GPS geometry cases the ATC system could discard the data when the data is in fact useable. Will be perceived as loss of ADS-B data.	Can be treated in the same manner as a loss of transponder capability.
12.	Intermittent wiring GPS transponder	ADS-B transmissions switch intermittently between INS position and GPS position.	**Yes.** Normally the integrity data goes to zero when INS is broadcast, but sometimes during transition between INS and GPS, an INS position or two can be broadcast with "good" NUC value. Disturbing small positional jump.	If a new case is discovered, an entry needs to be made to the black list until rectification has been effected.
13.	Wrong 24 bit code	Installation error	**No.** No direct ATC impact unless a rare duplicate is detected.	This is not a direct ADS-B problem, but relates to a Mode S transponder issue that can put TCAS at risk. Cannot be fixed by black list entry. Needs to be passed to regulator for resolution.
14.	Toggling between high and low NUC (See Figure 5)	Faulty GPS receiver/ADS-B transponder	**No.** ATC will see tracks appear and disappear discretely. No safety implications to ATC.	While it is normal for NUC value to switch between a high and low figure based on the geometry of GPS satellites available, it is of the view that more should be done to examine this phenomenon. It is observed that

Ref.	Problem	Cause	Safety Implications to ATC (Yes / No)	Recommendations
				such switching between high and low NUC occurs on certain airframe and not on others. The issue was raised to the airlines so as to get a better understanding. On one occasion, the airline replied that a module on their GPS receiver was faulty. On another occasion, the airline replied that one of the ADS-B transponder was faulty. Good NUC was transmitted when the working transponder was in use and poor NUC was transmitted when the faulty ADS-B transponder was in use.
15.	Consistent Low NUC (See Figure 6)	GNSS receivers are not connected to the ADS-B transponders.	**No.** Data shall be filtered out by the system and not detectable in ATC	Not considered a problem but a common phenomenon in the Region – the concerned aircraft will be treated equivalent to "aircraft not equipped with ADS-B". While it is normal for aircraft to transmit low NUC, it is of the view that "consistent low NUC' could be due to the avionics problem (e.g. GNSS receiver is not connected to the ADS-B transponder). Concerned airline operators are required to take early remedial actions. Otherwise, their aircraft will be treated as if non-ADS-B equipped which will be requested to fly outside

Ref.	Problem	Cause	Safety Implications to ATC (Yes / No)	Recommendations
				the ADS-B airspace after the ADS-B mandate becomes effective.
16.	ADS-B position report with good integrity (i.e. NUC >= "4") but ADS-B position data are actually bad as compared with radar (met criteria 5.2(a))	Faulty ADS-B avionics	**Yes.** As the ground system could not "automatically" discard ADS-B data with good integrity (i.e. NUC value >=4), there could be safety implications to ATC.	The problem should be immediately reported to the concerned CAA/operators for problem diagnosis including digging out the root causes, avionics/GPS types etc., and ensure problem rectification before the ADS-B data could be used by ATC. Consider to "blacklist" the aircraft before the problem is rectified.
17.	FLTID transmitted by ADS-B aircraft does not match with callsign in flight plan (see Figures 7a – 7d)	Human errors	**Yes.** Could lead to screen clutter - two target labels with different IDs (one for radar and another for ADS-B) being displayed, causing potential confusion and safety implications to ATC.	Issue regulations/letters to concerned operators urging them to set FLTID exactly match with callsign in flight plan.

Figure 1 - Track Jumping problem with TPR901

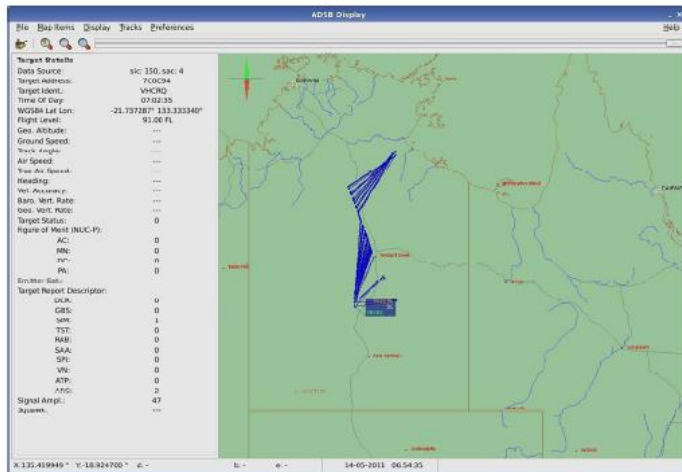

Figure 3 - Garmin "N" Flight ID problem

Figure 2 - Rockwell Collins TDR94 Old version. The pattern of erroneous positional data is very distinctive of the problem
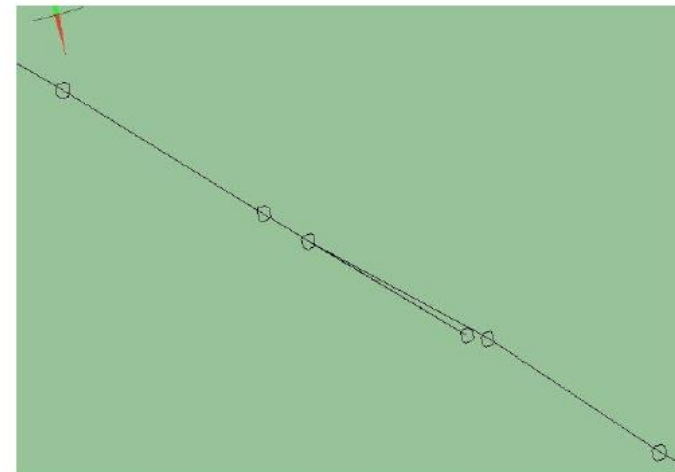

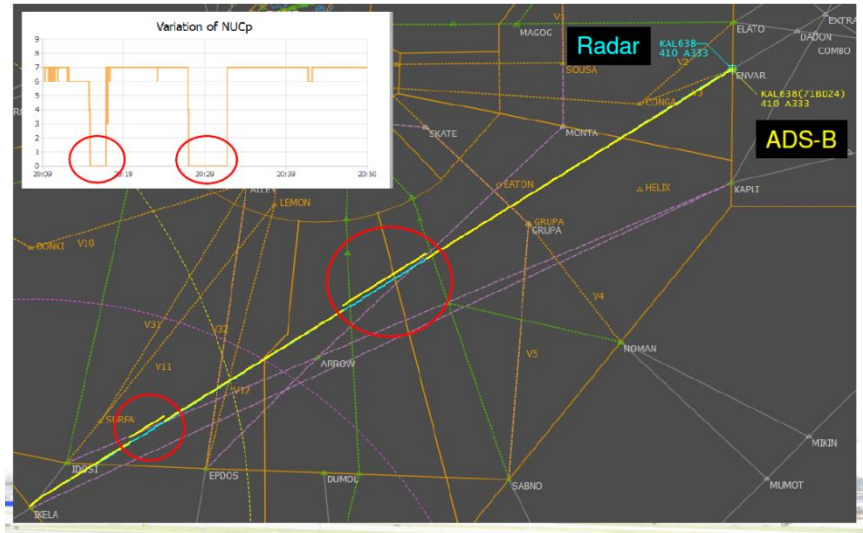Figure 4 - Occasional small position jump backwards
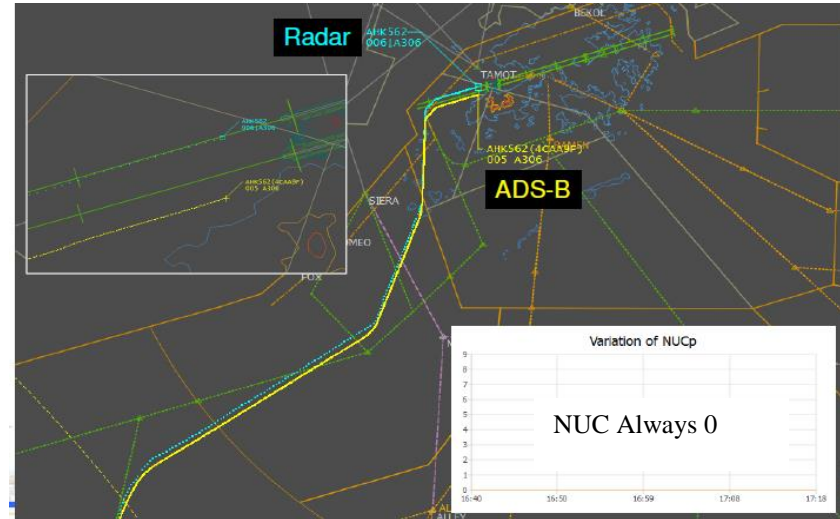
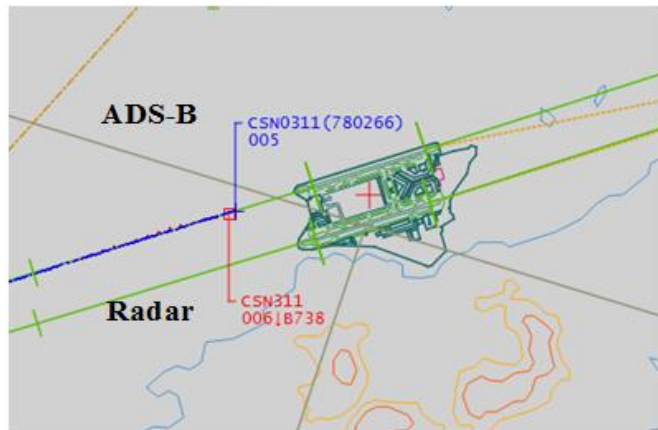Figure 5 - NUC value toggling

Figure 6 – Consistent low NUC
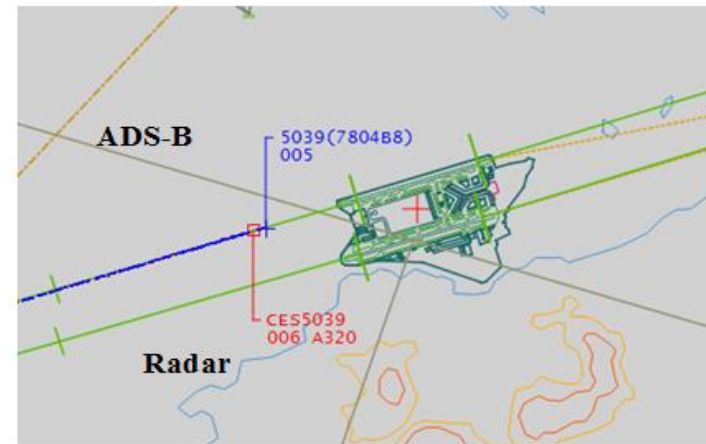
Figure 7a - Additional zero inserted

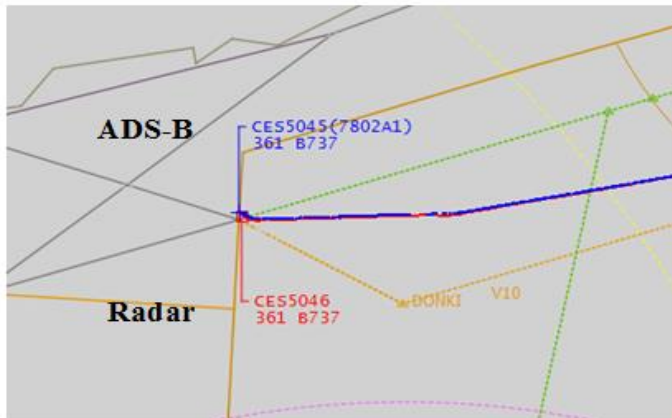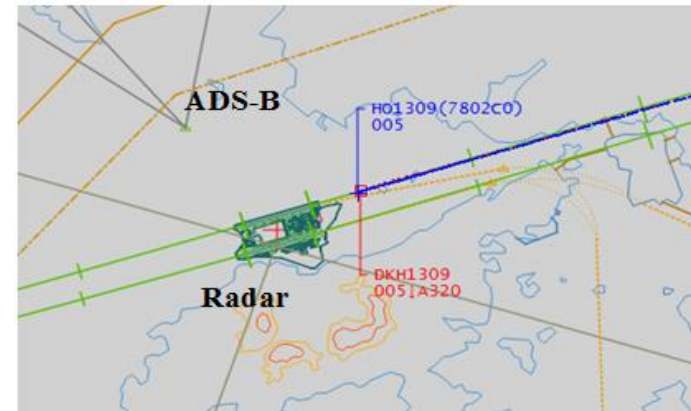Figure 7b - ICAO Airline Designator Code dropped

Figure 7c - Wrong numerical codes entered

Figure 7d - IATA Airline Designator Code used