International Civil Aviation Organization

AUTOMATIC DEPENDENT SURVEILLANCE – BROADCAST SEMINAR AND TWELFTH MEETING OF AUTOMATIC DEPENDENT SURVEILLANCE – BROADCAST (ADS-B) STUDY AND IMPLEMENTATION TASK FORCE (ADS-B SITF/12)

Kolkata, India, 15-18 April 2013

Agenda Item 5:   **ADS-B Performance Monitoring**

**PERFORMANCE MONITORING AND ANALYSIS OF
ADS-B EQUIPPED AIRCRAFT**

(Presented by Hong Kong China)

SUMMARY

This paper provides latest update of the proactive effort from Hong Kong China using an in-house developed system to perform monitoring and analysis of ADS-B equipped aircraft flying within Hong Kong Flight Information Region (HKFIR). Aircraft with mis-leading ADS-B data will be automatically detected by the system based on pre-defined criteria and will be reported to concerned CAA/operators for follow up actions. Aircraft identified with erroneous ADS-B data will be put on a "blacklist" if no improvement is made by the aircraft operator.. To facilitate harmonization of blacklisting criteria, this paper outlines a systematic algorithm to monitor performance of ADS-B aircraft, and a scheme for problem reporting and blacklisting. The paper also recommends inclusion of the algorithm and scheme into the AIGD as guidance materials for States who are ready to implement their own systems to monitor and analyse performance of ADS-B equipped aircraft.

1.   Introduction

1.1   During APANPIRG/23 and 49th DGCA Conference, Conclusions/Actions were formulated encouraging States/Administrations that were ready to perform safety monitoring using ADS-B data to share their analyzed ADS-B data and monitoring results with a view to establishing a database for the purpose of enhancing aviation safety. As a proactive step to meet this ambitious objective, Hong Kong China has developed a trial system to commence early performance monitoring and analysis of ADS-B equipped aircraft flying within HKFIR based on a systematic algorithm.

2.   Discussion

2.1   The ADS-B ground station infrastructure in Hong Kong is being built and expected to be in operation in late 2013. In parallel, a trial ADS-B ground station has been put in place to allow early commencement in performance monitoring and analysis of ADS-B equipped aircraft. As ICAO has not provided much guidance in this respect, Hong Kong China has steered to propose a systematic algorithm based on independent surveillance source (e.g. radar) and flight plan information to monitor and analyse performance of ADS-B equipped aircraft. At the beginning of each month, the system will intake all recorded information on ADS-B, radar targets data and flight plan within HKFIR for

the past one month in an offline manner. For each ADS-B flight, the system will compare it with radar and flight plan, and analyse if the following pre-defined criteria are met :-

(a) Deviation between ADS-B reported position and independent referenced radar position is greater than 1 NM for more than 5% of total number ADS-B updates within the HKFIR; or

(b) Navigation Uncertainty Category (NUC) accompanying each ADS-B reported position is smaller than 4 (see Note) for more than 5% of total number of ADS-B updates within the HKFIR; or

(c) Flight Identification (FLTID) entered via cockpit interface and transmitted in ADS-B data (i.e. I021/170 in Asterix CAT 21) does not match with aircraft callsign in the ATS Flight Plan for more than 5% of total number of ADS-B updates within the HKFIR.

2.2   Deviation between ADS-B and radar tracks being set at 1NM is in accordance with ICAO Circular 326 defining position integrity (NUC) shall be at least 4 (0.5NM < HPL < 1NM) for 3NM aircraft separation standard, on the assumption that radar targets are close to actual aircraft position. Taking into consideration the potential large number of identified occurrences meeting the criteria due to ADS-B mandate has yet been effective for most APAC States before 2013, a threshold of 5% is initially set to exclude aircraft exhibiting occasional problems during their flight journey within HKFIR. All these criteria are configurable to allow flexibility in fine-turning in future.

2.3   The system is capable of generating a list of aircraft meeting pre-defined criteria with full history records showing each occurrence meeting the criteria with information including Mode S address, date/time of occurrence, screen capture of radar and ADS-B history tracks, graphs showing NUC value changes and deviation between radar and ADS-B tracks along the flight journey (see Appendix 1). The system has monitored and analysed some 137,370 ADS-B flight movements over 4 months from December 2012 – March 2013 within the HKFIR and identified the following three major problem categories :-

2.3.1   Cat. I : ADS-B position report with no integrity (i.e. NUC always "0") and ADS-B position data are bad as compared with radar (see Appendix 2). Some 2,149 (1.6%) ADS-B flights monitored are identified under this category. The situation usually occurs when GPS receiver is not connected with ADS-B transponder which broadcasts inertia position data. The problem should be reported to CAA/operators for rectification before the ADS-B data could be usable by ATC.

2.3.2   Cat. II : ADS-B position report with no integrity (i.e. NUC always "0") but ADS-B position data are good as compared with radar (see Appendix 3). Some 5,533 (4%) ADS-B flights monitored are identified under this category. The situation should be reported to CAA/operators for rectification, otherwise ADS-B position data despite close to radar will be discarded by ground systems.

2.3.3   Cat. III : FLTID transmitted by ADS-B does not match with callsign in flight plan

FLTID is set by pilot via cockpit interface which enables ATC to identify an aircraft on the display and to correlate an ADS-B track with flight plan. Mismatch between FLTID and aircraft callsign in flight plan might lead to screen clutter - two target labels (one for radar and another for ADS-B) are displayed instead of one, causing potential confusion and safety implications to ATC. Some typical examples are given in Appendix 4. Some 6,066 (4.4%) ADS-B flights are identified under this category.

Note: For the next value of NUC smaller than 4, i.e. NUC = 3, the Horizontal Protection Limit (HPL) is greater than 1.0 NM.

2.4   For each ADS-B equipped aircraft flying within HKFIR, the system will monitor its performance and record their recurrences of the above categories. Local registered aircraft having high recurrence (say on average of six times per month) will be reported to concerned operators for taking remedial actions. After sending rectification advice, the concerned aircraft will be monitored for a reasonable period (say two months) to check improvement before entering into the "Blacklist". As the system could also monitor performance of foreign registered aircraft within HKFIR, for purpose of enhancing aviation safety for the Region, Hong Kong China propose to pass the monitoring results to ICAO for taking remedial actions with concerned CAAs. The parameters in the scheme for reporting problematic aircraft to CAA/operators and blacklisting need to be fine-tuned taking into consideration factors such as monitoring/reporting burden and lead-time for rectification. It is believed that the scheme together with publication of ADS-B mandate requiring identified deficiencies to be rectified or otherwise lower priority to access ADS-B airspace (i.e. at FL 290 and above) will provide sufficient incentives to concerned parties for early rectification.

2.5   Based on the proposed algorithm to systematically monitor performance of ADS-B equipped aircraft flying within airspace with full/partial radar coverage, and the scheme to report/blacklist aircraft, it is recommended to include the proposed algorithm and scheme into the AIGD as guidance materials applicable to States with full/partial radar coverage and are ready to perform monitoring and analysis of ADS-B equipped aircraft.

2.6   As the proposed algorithm requires independent surveillance source (e.g. radar), further deliberation with guidance/assistance from ICAO is required for those airspace without radar coverage. Besides, following the Conclusions/Actions arising from APANPIRG/23 and 49th DGCA Conference, it is recommended that a mechanism to be developed for States to share analyzed ADS-B data and monitoring results for enhancement of aviation safety.

3.   Action by the Meeting

3.1   The meeting is invited to:

a)   note that Hong Kong China has developed a trial system to perform monitoring and analysis of ADS-B equipped aircraft flying within HKFIR for enhanced aviation safety;

b)   note that Hong Kong China has steered to propose an algorithm to systematically monitor performance of ADS-B equipped aircraft based on independent surveillance source, and a scheme to report/blacklist aircraft;

c)   formulate a draft Conclusion to adopt the proposed algorithm and scheme into the AIGD as guidance materials;

d)   seek assistance from ICAO to take remedial actions with concerned CAAs on problematic aircraft flying within a State's airspace not locally registered; and

e)   develop a mechanism for States to share analyzed ADS-B data and monitoring results with a view to establishing a database for enhanced safety.

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Radar and ADS-B History Tracks

Mode S address of problematic aircraft

Date/time of each occurrence with problem identification

Profile of NUC value along journey

Profile of deviation between Radar and ADS-B position

5	00B1F2			1	1
6	00B1F3			1	1
7	00B1F4			1	1
8	04000A	7	14		21
9	04000E			1	1
10	040012	1	1	1	3
11	040016	2	2		4
12	04001B	8	8	1	17
13	04001C	7		1	16
14	04001D	18	26	1	45
15	040021	7	8	2	17
16	040034		4		4
17	04006E	14	17		31
18	04C029	4	4		8
19	04C02B		2		2
20	04C02F			1	1
21	04C036		2	2	

☐ Dev ☐ NUCp ☐ CS

Total: 1392   Export

Time
2012/12/01 10:52:20 – 11:20:33 DN
2012/12/01 14:44:20 – 15:18:32 N
2012/12/11 09:14:50 – 09:47:51 N
2012/12/11 14:12:51 – 14:46:13 N
2012/12/13 09:21:06 – 10:03:21 N
2012/12/13 14:26:24 – 15:00:24 DN
2012/12/22 12:03:30 – 12:34:47 DN
2012/12/22 15:29:41 – 16:04:21 DNC
2013/01/04 09:18:26 – 09:48:26 DN
2013/01/04 13:58:01 – 14:32:21 DN
2013/01/10 09:24:35 – 09:55:27 DN
2013/01/10 14:02:46 – 14:38:09 DN
2013/01/12 09:29:11 – 10:05:57 N
2013/01/12 14:17:38 – 14:53:23 N
2013/01/14 09:07:56 – 09:38:31 DN

Num. of Tracks: 26

Summary

Total ADSB Flights	137370
Track Position	
Bad DEV only	77
Bad DEV	2226
Bad NUCp only	5533
Bad NUCp	7682
Incorrect Callsign	6066

ETH608(04001D)
0051B763

ETH608
006 B763

RAMEN
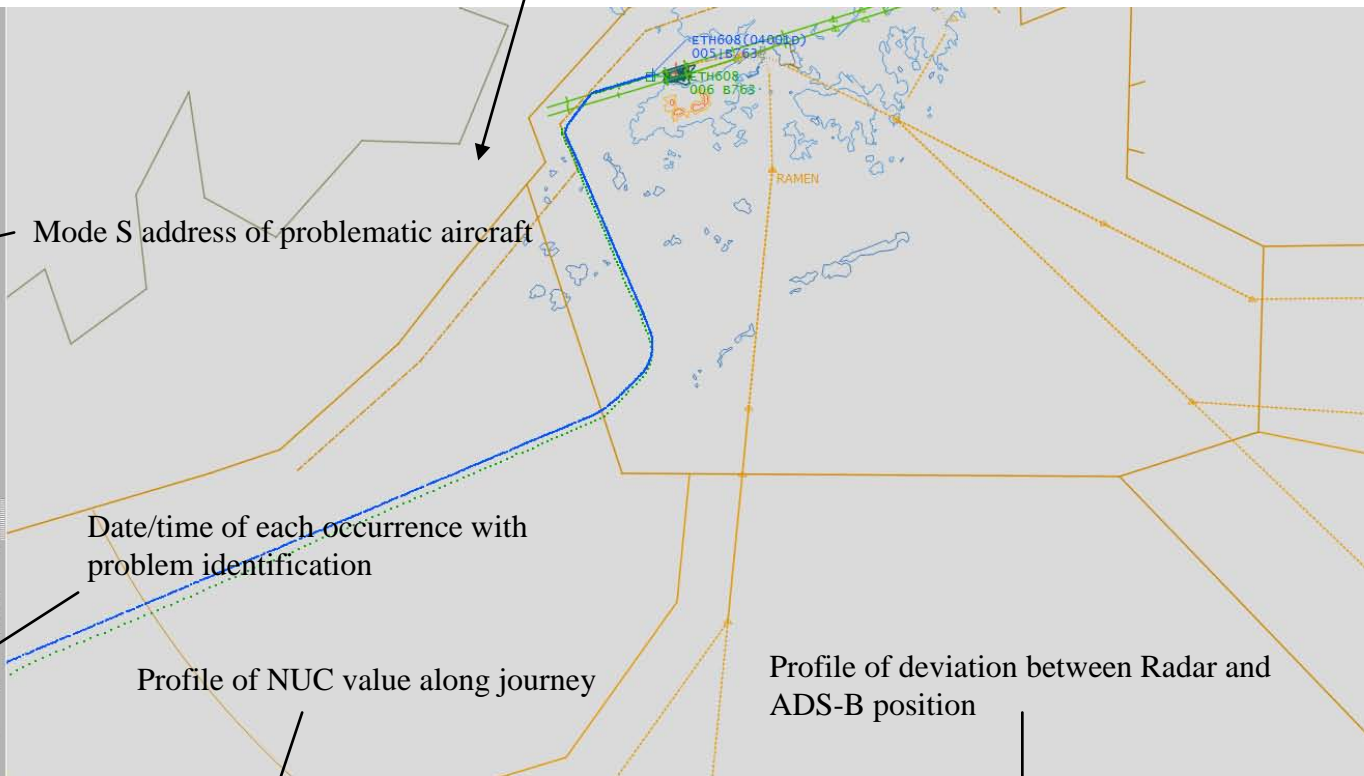
Callsign	ETH608
Mode S	04001D

Deviation
Average	1.38
Percentage	
Vertical	0.00
Horizontal	40.98
Overall	40.98

NUCp
Average	0.00
Percentage	100.00

Reference Track
Callsign	ETH608
Mode3A/S	A6103

Black List Criteria
Dev > 1 NM or 1500 ft for 5
updates
NUCp < 4 for 5% of updates
Incorrect Callsign

NUCp   Variation of NUCp

Deviation   Variation of Deviation

Statistics

Black List Daily Stati

Duration: ● 3 m ● 6 m

22 26 29.19 N, 113 04 12.73 E
RING: OFF
RANGE: 106 NM

CPA740
005 A333
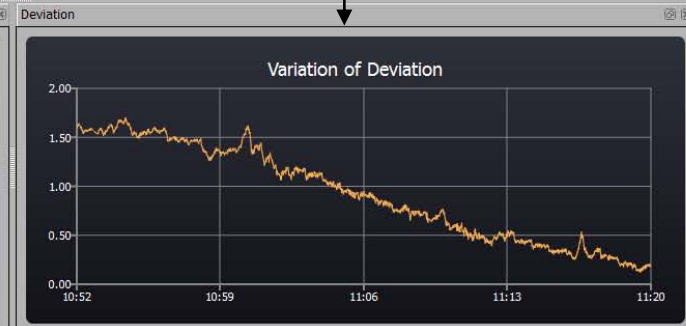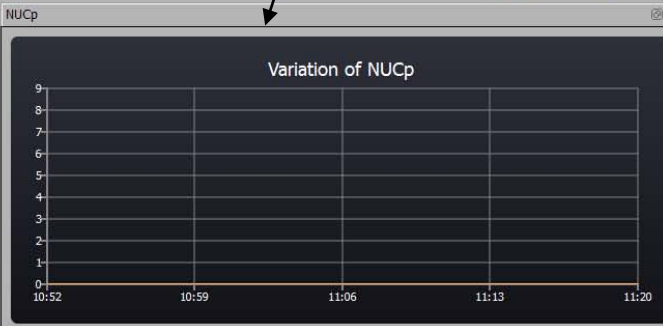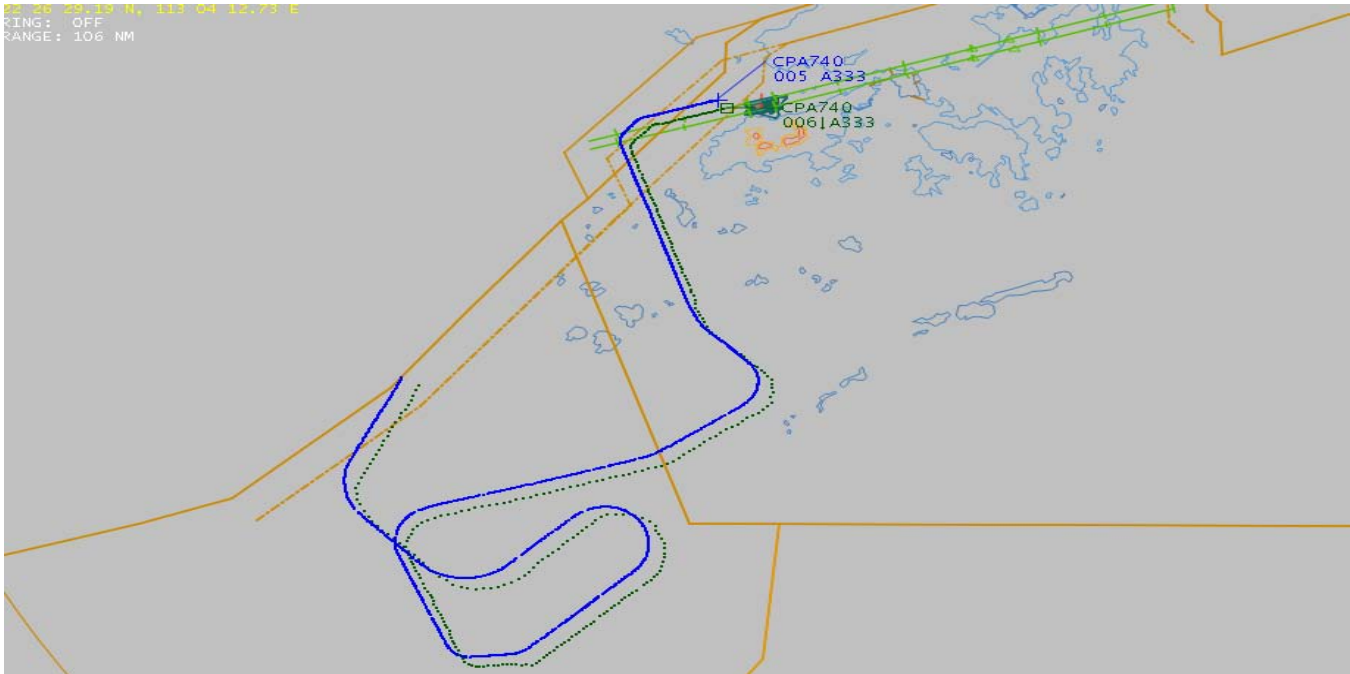
CPA740
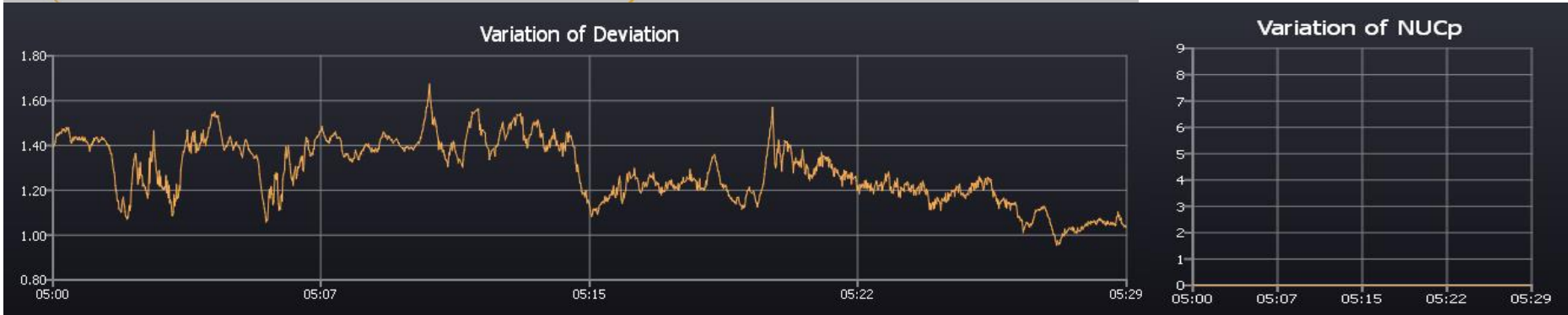006 A333

Radar Track

ADS-B Track

Date
7/2/2013

Time (UTC)
05:00:29 – 05:29:49

Callsign
CPA740

Mode S Address
7801C9

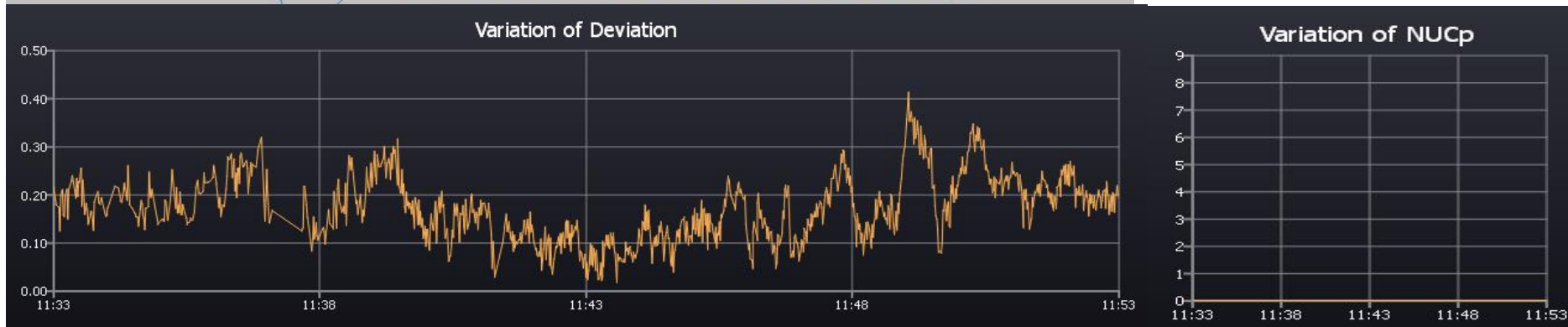**Average Deviation between
ADS-B and Radar**
1.28NM

Variation of Deviation

Variation of NUCp

RANGE: 19 NM

VLK4674
005 T204

VLK4674
005 T204
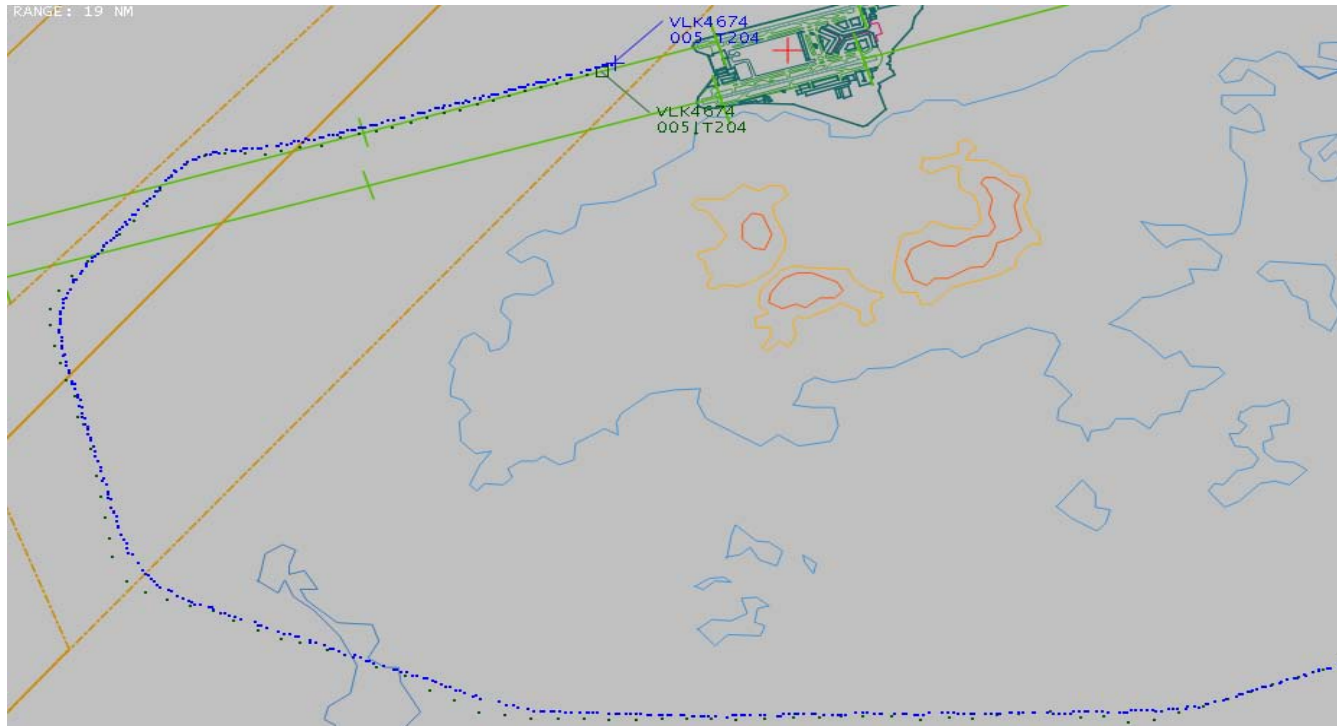
ADS-B Track

Radar Track

Date
15/12/2012

Time (UTC)
11:33:35 – 11:53:43

Callsign
VLK4647

Mode S Address
14FA27

Variation of Deviation

Variation of NUCp
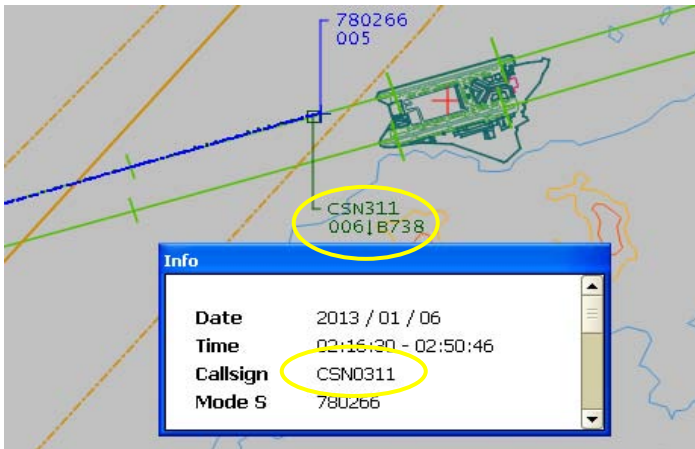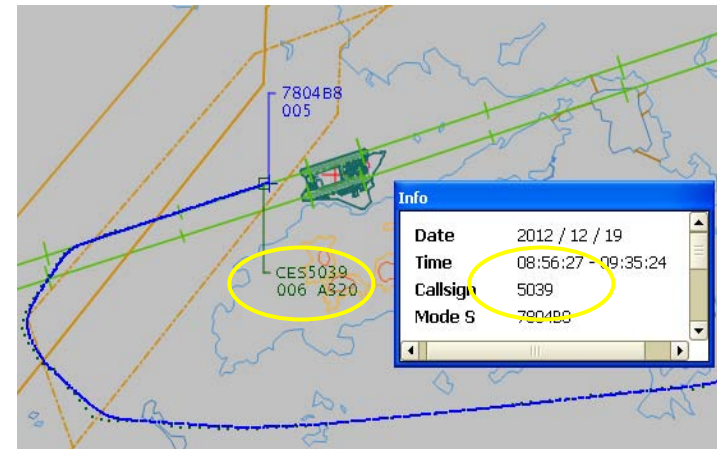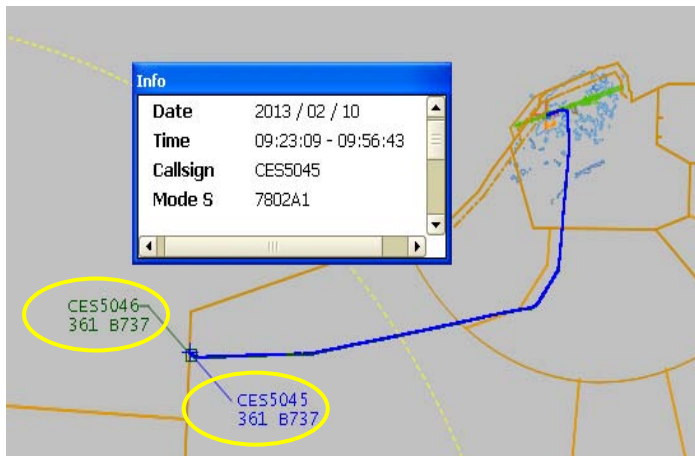
Additional zero inserted

ICAO Airline Designator Code dropped

Wrong numerical codes entered

IATA Airline Designator Code used