International Civil Aviation Organization

THE NINTH MEETING OF THE SOUTHEAST ASIA AND BAY OF BENGAL SUB-REGIONAL ADS-B IMPLEMENTATION WORKING GROUP (SEA/BOB ADS-B WG/9)

Beijing, China,   30 October - 1 November 2013

Agenda Item 6:   Need for monitoring and improvement in compliance

PERFORMANCE OF ADS-B STATIONS AND AVIONICS IN SINGAPORE FIR

(Presented by Singapore)

SUMMARY

This paper shares with the Working Group the performance of the ADS-B ground stations and the avionics operating in the Singapore FIR.
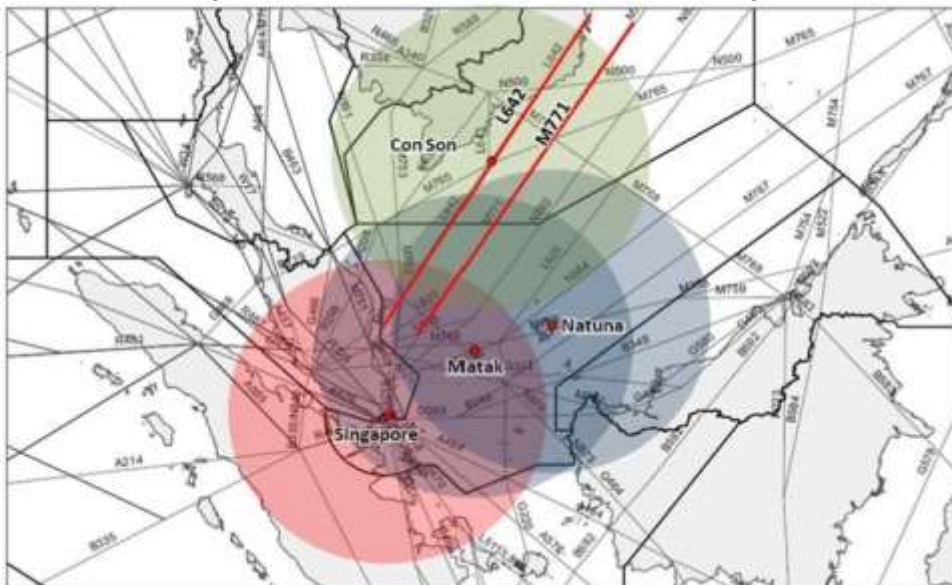
1.   INTRODUCTION

1.1   This paper shares with the Working Group, the performance of the ADS-B grounds stations and the avionics operating in the Singapore FIR.
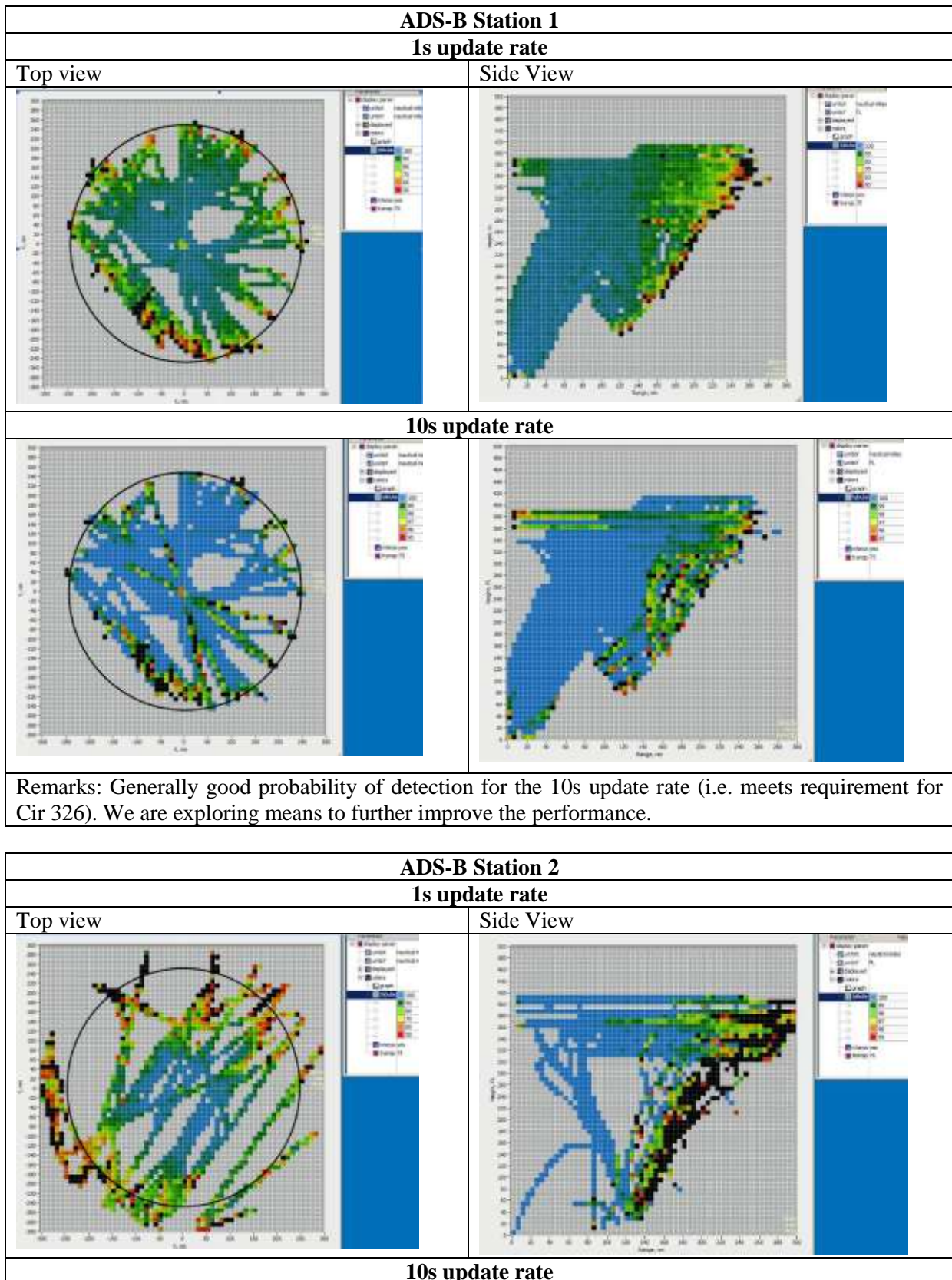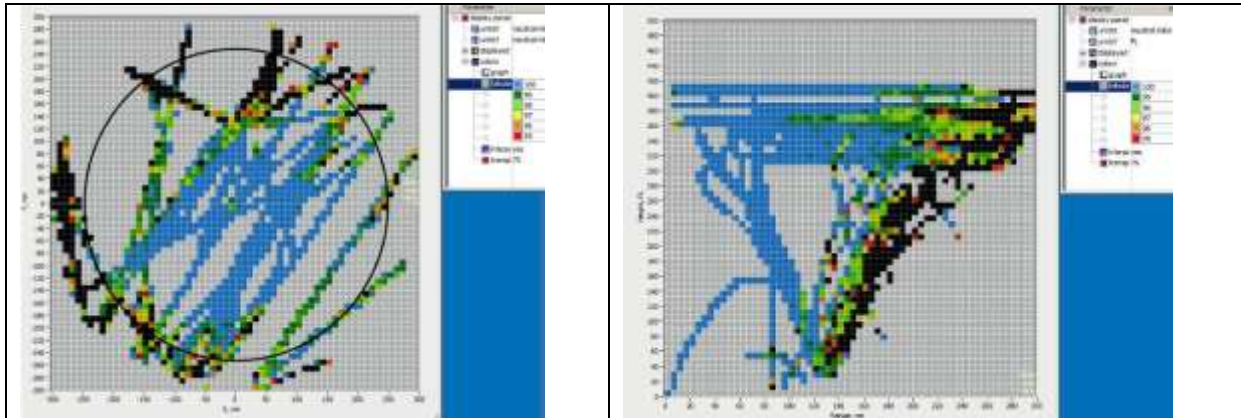
2.   DISCUSSION

ADS-B Ground Stations

2.1   Singapore is using the ADS-B data from Con Son, Matak, Natuna and Singapore. The theoretical coverage of the ADS-B stations are shown in the diagram below:

2.2   Using various analysis techniques and tools, the performances of the various ADS-B stations are shown below:

ADS-B Station 1
1s update rate

Top view	Side View

10s update rate

Remarks: Generally good probability of detection for the 10s update rate (i.e. meets requirement for Cir 326). We are exploring means to further improve the performance.

ADS-B Station 2
1s update rate

Top view	Side View

10s update rate

Remarks: Generally good probability of detection for the 10s update rate up to 250NM, towards the southern portion. Due to height of ADS-B station, the coverage extends well beyond 250NM to 300NM. We are exploring with the OEM on the means to further improve the performance, so as to take advantage of the height.
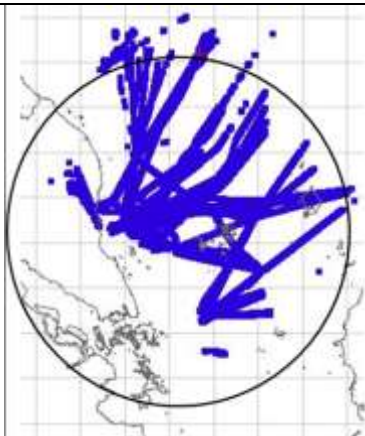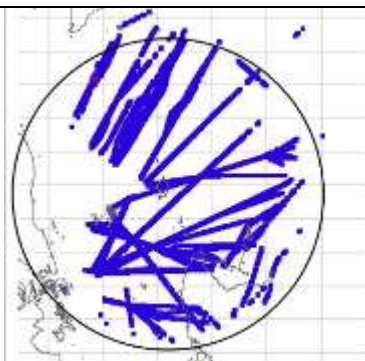
ADS-B Station 3	
  Probability of detection of 30% based on 1s update rate.	Remark: While coverage goes beyond 250NM towards the North, it can be observed that the range is limited towards the other directions.

| ADS-B Station 4	
  Probability of detection of 30% based on 1s update rate.	Remark: Coverage goes beyond 250NM at certain directions. A blockage is observed towards the Eastern part. The blockage is due to the mountainous area.

Latency of messages observed at ATC System

2.3   The latency of the messages (difference between time of reception by ATC system and message timestamp) are within 2.5s. According to ICAO Cir 326, the maximum latency (we assume it includes both uncompensated and compensated latency) means allowed is 4s. EASA AMC20-24 allows for 1.5s of uncompensated latency for the airborne transponder. ED129 allows for 0.5s for the ADS-B ground station to output the ASTERIX report. This leaves 2s for the network and any processing (such as data fusion, up/down conversions) in the filters. Our measured latency of 2.5s is 0.5s longer than the allowed 2s. To overcome this, one mitigating measure is to set the minimum NUC to be 4, instead of 3 as allowed by ICAO Cir 326.
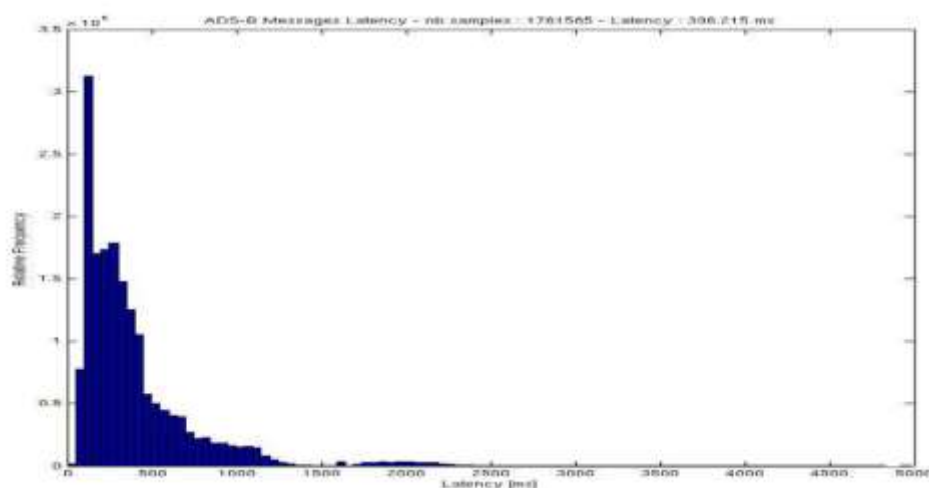
ADS-B Equipage over L642 and M771

2.4   As Singapore is commencing ADS-B operations over the route L642 and M771, a study was made on the equipage level on these two routes over several days. For L642, the equipage level ranges from 78% to 91%. For M771, the equipage level ranges from 74% to 81%.

Aircraft equipage along L642			
Date	ADS-B equipped aircraft	Total number of aircraft	ADS-B Equipage (%)
19-Aug-13	88	112	78.57
20-Aug-13	104	120	86.67
24-Aug-13	92	109	84.40
25-Aug-13	106	116	91.38
26-Aug-13	92	108	85.19
27-Aug-13	101	116	87.07
28-Aug-13	92	107	85.98

Aircraft equipage along M771			
Date	ADS-B equipped aircraft	Total number of aircraft	ADS-B Equipage (%)
19-Aug-13	83	104	79.81
20-Aug-13	80	107	74.77
24-Aug-13	80	99	80.81
25-Aug-13	82	102	80.39
26-Aug-13	89	111	80.18
27-Aug-13	84	106	79.25
28-Aug-13	78	102	76.47

Probability of Detection along L642 and M771

2.5   The probability of detection on a per-aircraft basis was done on a sample of 10 aircraft over seven days. It can be observed that the probability of detection is generally high.

Probability of detection along L642								
		Probability of detection based on 1s update rate[1]						
Callsign	24 bit	19-Aug	20-Aug	24-Aug	25-Aug	26-Aug	27-Aug	28-Aug
AHK327	78013E	97.9	96.6	94.2	NA	96.6	98.2	95.1
AXM1017	75015B	92.3	95.6	91.1	97.2	85.6	92.4	93. 3
CCA969	7803AE	78.3	82.1	85.0	81.3	78.9	77.9	83.7
CPA711	78019C	74.2	67.7	85.8	69.3	77.2	NA	84.8
JSA696	76AA6F	84.0	82.1	88.7	97.0	90.9	89.9	90.1
MAS389	750255	73.4	77.9	79.7	72.9	69.1	65.7	76.5
MAS73	750292	74.9	79.2	75.7	71.9	75.2	76.8	NA
SIA801	76CF27	95.9	98.1	97.9	97.9	98.1	97.6	97.7
TGW2063	76D038	72.0	73.0	81.8	80.8	69.5	76.4	72.0
XAX317	7502CD	61.0	81.4	72.5	NA	76.7	64.0	62.5

Probability of detection along M771								
		Probability of detection based on 1s update rate						
Callsign	24 bit	19-Aug	20-Aug	24-Aug	25-Aug	26-Aug	27-Aug	28-Aug
AHK326	7801DE	73.1	80.4	79.5	NA	79.6	86.0	81.4
CCA970	7809A6	92.6	96.9	96.0	95.3	94.3	97.1	98.1
CPA716	780173	88.6	82.9	84.7	82.7	82.2	84.3	83.4
EVA228	8990C4	70.4	76.1	68.3	71.9	65.9	NA	71.4
GIA894	8A01DA	97.2	91.9	94.3	94.4	91.0	95.5	93.7
JSA695	76AA6F	84.8	80.0	82.9	87.8	79.0	79.6	81.4
MAS380	75020A	75.8	78.6	78.7	75.2	77.8	76.2	66.9
SIA860	76CE4F	75.4	78.3	86.1	84.9	81.4	79.8	80.5
TGW2062	76D038	95.6	97.4	93.8	96.9	89.2	96.3	95.0
XAX330	7501FB	NA	72.6	72.4	74.9	72.6	77.4	NA

Note: 1 "NA" means the aircraft did not fly the said route on that day.

Toggling between high and low NUC

2.6   While it is normal for NUC value to switch between a high and low figure based on the geometry of GPS satellites available, we were of the view that more could be done to examine this phenomenon. We observed that such switching between high and low NUC occurs on certain airframe and not on others. We hence raised the issue with the airlines so as to get a better understanding.

2.7   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.

Airline with NUC that jumps from high to low			
24-bit code	Operator	Issue	Low NUC duration
76CEC8	Singapore Airlines	jumping from NUC 6,7 to 0	45mins
76CE2C	Singapore Airlines	jumping from NUC 6,7 to 0	30mins
76CECC	Singapore Airlines	jumping from NUC 6,7 to 0	50mins
75014C	AirAsia	jumping from NUC 6,7 to 2	30mins
8A0368	Lion Air	jumping from NUC 6,7 to 2	40mins
8991B6	Taiwan	jumping from NUC 6,7 to 4	40mins

Consistent low NUC

2.8   While it is normal for aircraft to transmit low NUC, we were of the view that it could be due to the avionics problem. However, we had difficulty getting responses from airlines on this issue.

Airline with low NUC		
24-bit code	Operator	Pre-dominant NUC value
6000A	Air Mauritius	2
7BB108	China Southern Airlines	3
780105	China Southern Airlines	3
88000F	Thai Airways International	3
7BB108	China Southern Airlines	3
7BB107	China Southern Airlines	3
780105	China Southern Airlines	3
7581F6	Zest Airways	3
7BB108	China Southern Airlines	3

Deviation with radar tracks

2.9   Generally, the track from ADS-B coincides with that of the long range radar within 0.5 NM. Occasionally, significant deviations were observed. However, as we noted that number of scans were relatively few, such statistic were not conclusive and considered as outliers.

Operator	24-bit code	ADS-B reports	Radar scans	Mean Difference[1] (m)	Standard Deviation[2] (m)
Emirates	896187	228	27	33.792	140.589
Japan Airlines	86D646	292	27	33.914	70.624
Airasia	750074	258	27	35.22	114.617
Garuda Indonesia	885041	245	27	36.523	101.872
Emirates	896215	195	27	38.889	148.677
Garuda Indonesia	8A01F1	25	2	409.192	675.183
Silkair	76CD88	19	2	468.373	646.229
Malaysia Airlines	7502B1	43	2	469.514	659.3

Note: 1. Distance between radar reported position and ADS-B reported position.
2. Standard deviation of the distance between the radar reported position and ADS-B reported position.

Wrong 24 bit code

2.10   There was a detection of an aircraft with call-sign "UZB551" and 24 bit code "400187". The 24-bit code is within the range of the 24 bit codes reserved for the United Kingdom registration aircraft. A notification was sent to UK NATs and the regulator of Uzbekistan.

3.   ACTION BY THE MEETING

3.1   The meeting is invited to:

a)   note the above information; and

b)   urge airlines to assist ANSPs in the understanding and resolution of issues.

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