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

UPDATE ON TPR901 PROBLEM

(Presented by Airservices Australia)

SUMMARY

This paper provides an update on a previously reported issue where longitude jumps have been observed in ADS-B position reports.

ANSPs need to be aware of the potential issue and protect against it.

1. INTRODUCTION

1.1 Australia has previously reported on the problem of ADS-B positional data jumps from aircraft with the Rockwell TPR901 transponder over a number of years.

1.2 The symptom is that on some small number of flight legs, only from some Airlines, there are numerous incorrect longitude reports.

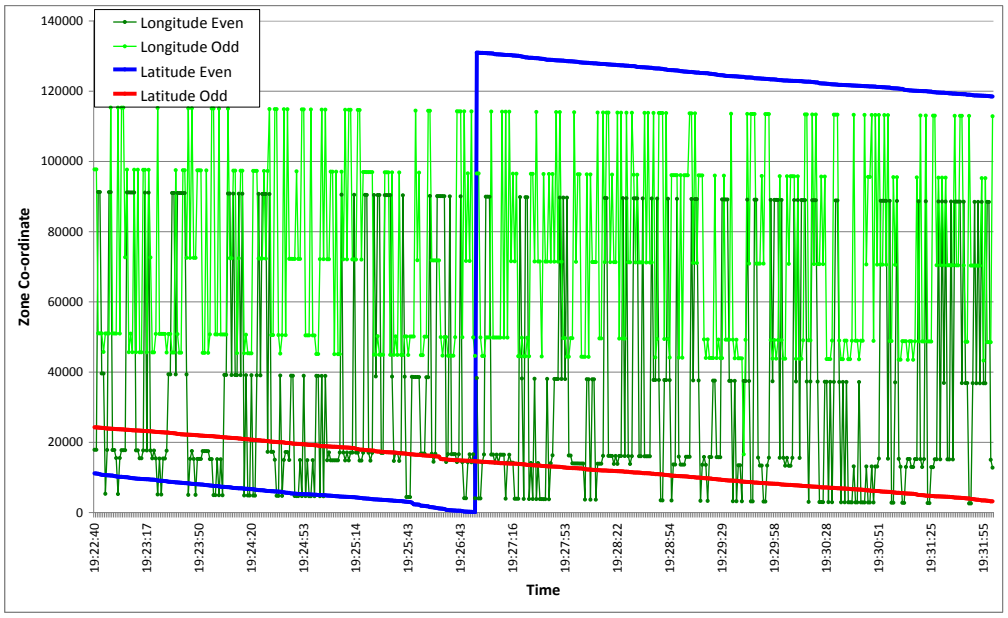
1.3 ANSP's normally have algorithms to detect erroneous jumps and remove the erroneous data. However, typically, some false position reports "get through" these algorithms. Even when the algorithms work successfully, the ADS-B data is no longer available to ATC.

1.4 Rockwell Collins has successfully introduced a Service Bulletin that solves the problem in Boeing aircraft. However, as reported at previous meetings, Australia has observed the problem with a number of Airbus aircraft. Rockwell has advised that a solution will not be available in the near future because of their commitment to DO260B development.

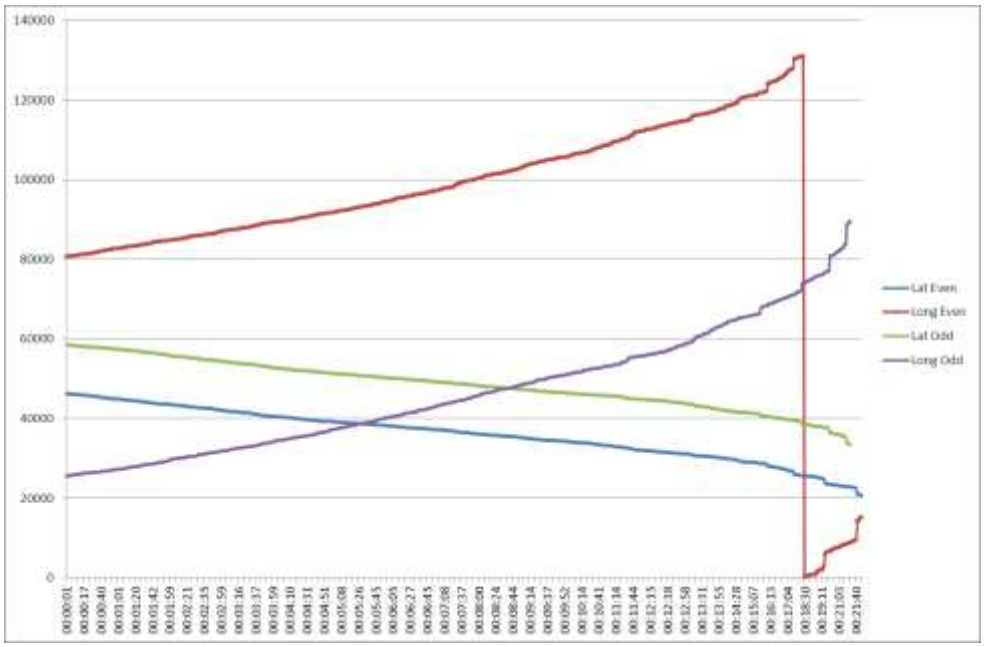
1.5 The TPR901 transponder is used in a large number of commercial airliners.

2. FURTHER INVESTIGATION

2.1 During the last months this issue has been investigated further by Rockwell Collins and Airservices Australia. In one case, the ADS-B transmissions from an aircraft were examined prior to CPR decoding. Encoded latitude and longitude bin values were plotted for both odd and even messages.



2.2 The data shows that even prior to decoding the aircraft position the encoded values for longitude exhibited multiple jumps. Normally these values should follow a saw tooth pattern with jumps corresponding to when the aircraft position crosses a zone boundary as shown below :



2.3 The continuous jumping pattern on the longitude values suggested that the problem was occurring prior to the decoding process.

2.4 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.

2.5 On some crossings (1 out of 10) 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. For example one airline operated as follows :

Incheon-Hawaii – across 180 degrees longitude – possibly triggering the problem
Hawaii- Incheon – again across 180 degrees longitude – possibly triggering the problem
Incheon-Narita-Incheon
Incheon-Cebu-Incheon
Incheon-Shanghai-Incheon
Incheon-Bali == where the problem was first observed !

2.6 Finally understanding the root cause of the problem has explained many aspects of this issue that has been observed in Australian airspace for many years. In particular why it has only occurred with aircraft flying over the Pacific Ocean (or on subsequent flights into Australia after crossing the Pacific on previous legs without a transponder power reset) and not been observed in Europe.

2.7 In each case where this issue has been observed in Australian Airspace, the receiver was able to detect and throw away the vast majority of incorrect position reports. However, during track initiation, when presented with a sequence of consistently encoded position reports but based on an incorrect aircraft position the receiver was unable to determine if these were correct and some data was passed to the ATC system. Only when a jump in the aircraft position was received did a track re-initiation occur.

2.8 The data includes sequences of odd and even reports for longitude that are consistent but do not necessarily represent the correct aircraft position. These sequences could be decoded globally to produce a position that passes the reasonableness tests but does not represent the true aircraft position.

2.9 There is no indication to the receiver that the position is incorrect until, in this case, the longitude values jump and the track is dropped and the global decoding sequence starts again with a new set of received messages.

2.10 The reasonableness tests are designed to catch errors introduced during the CPR process which can occur if the limitations are not correctly observed. From the data seen during investigation of this problem it is clear that these tests will not necessarily catch consistent errors introduced into the position before encoding. The decoder can only decode what was once encoded.

2.11 The data generated by the transponder clearly does not comply with the intention of the standards and so would not normally be encountered by a receiver. However the implementation of a reasonableness check in the transponder either before and/or after the CPR encoding may detect any position jumps before transmission.

2.12 One option could be to compare the most recent position from the GPS to the position that is about to be encoded which may have come through a filter process.

3. ANSP CONSIDERATIONS

3.1 Rockwell Collins may not have a fix for some time. Workaround solutions are being examined by Airbus, Operators and Airservices.

3.2 The only workaround identified at this time is to power down the transponders before flight to states using ADS-B – after crossing latitude 180. It can be noted that in Airbus aircraft it is not possible to safely power down the transponder in flight. Airbus is preparing a procedure to support power down before flight.

3.3 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, the chance that both transponders being affected is 1%.

3.4 There is no workaround available for flights that operate directly to Asia-Pacific destinations from 180 degrees longitude. Australia will use a "blacklist" to remove all ADS-B transmissions from ATC display that are so identified.

4. FURTHER CONSIDERATIONS

4.1 Australia has raised related issues with the ICAO Aeronautical Surveillance Panel as follows

a) *Transponder Certification :* Consideration if there may be a deficiency in the test procedures such that this state was not triggered and observed during testing

b) *Reasonableness Checks on Aircraft Position :* Consideration of whether software tests are required inside the transponder

5. ACTION BY THE MEETING

5.1 The meeting is invited to:

a) note the information contained in this paper; and

b) discuss any relevant matters as appropriate

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