International Civil Aviation Organization

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Bangkok, Thailand, 12-16 July 2004

Agenda Item 4: Aeronautical Mobile Service

1) review operation of CPDLC

DELAYED DATA LINK DOWNLINK MESSAGES FROM AIRCRAFT IN AUSTRALIAN AIRSPACE

(Presented by Australia)

SUMMARY

This paper describes a problem that has been identified involving the receipt of delayed data link downlink messages from aircraft in Australian airspace.

1. Background

1.1 ADS-C (Automatic Dependent Surveillance Contract) has been used by Australian air traffic controllers for surveillance outside radar coverage since the transition to TAAATS (The Advanced Australian Air Traffic System) in 1999. Since this time, an increase in the number of data link (FANS-1/A) equipped aircraft and operators has occurred, this increase becoming more rapid in the last eighteen months.

1.2 From an Air Traffic Control (ATC) perspective, the use of ADS-C has greatly improved surveillance, provided improved alerting capabilities and facilitated the provision of enhanced services to data link equipped aircraft. In recent times, however, problems relating to the occasional delayed receipt of late ADS-C reports and/or CPDLC downlinks have been observed.

2. Description of Problem

2.1 The problems that have been observed manifest themselves in a number of ways:

- ADS-C reports not being received within a system parameter (VSP) of the expected time of receipt; and/or
- No *initial* response being received to CPDLC uplinks, and when the downlink reply is eventually received, the time stamp indicates that the downlink message was delayed in transit;
- CPDLC downlink requests being received with a time stamp indicating that the message was delayed in transit.

These delays appear to only affect aircraft operating outside VHF data link coverage.

2.2 In accordance with international agreements, details of these delays were passed as "Problem Reports" (PRs) to the FANS Interoperability Team (FIT) Central Reporting Agency (CRA), but their initial investigations were inconclusive. No links or trends could be identified from the information provided in these reports. Possible factors such as satellite congestion, aircraft SATCOM antenna location, 'gaps' in satellite coverage etc were all considered but were determined to not be causal factors in this particular problem.

2.3 However, from the perspective of air traffic controllers who were regularly encountering this problem, several trends were becoming evident:

- Delays appeared to be generally restricted to certain locations within the airspace. The time for the aircraft to transit these problem areas appeared to be in the order of 10 to 15 minutes, before operations returned to "normal";
- Delays appeared to be associated with certain aircraft types;
- When an aircraft was affected by these data link delays, *no* downlinks (ADS-C or CPDLC) were received. Observations indicated that functionality returned to normal for both applications (ADS-C and CPDLC) at approximately the same time;
- In some locations, the delays appeared to be 'direction specific'. Eastbound flights were affected, but the same aircraft tracking westbound operated without any observed problems;
- The frequency of occurrence of these delays appeared to be increasing *(which was possibly related to increasing numbers of data link equipped aircraft).*

2.4 During discussions with ATC colleagues in Melbourne Centre, it was learned that they were experiencing similar problems in regions of the Indian Ocean airspace.

2.5 As a result of what appeared to be a worsening problem, an analysis of ADS-C reports received by Brisbane (YBBB) and Melbourne (YMMM) Centres over a 6 month period was conducted. The purpose of this analysis was to:

i) Gain an indication of the relative frequency of these 'delayed' ADS-C reports;
ii) Identify any problem locations (if any) where delayed reports were more prevalent; and
iii) Identify whether the problem was possibly related to a specific airline or aircraft type.

3. Description of Analysis

3.1 All ADS-C reports received by Brisbane (YBBB) and Melbourne (YMMM) Centres over a six month period were analysed on a month by month basis. This analysis involved determining the transmission delay for each ADS-C basic report. This transmission delay was defined to be the difference between the time stamp contained in the ADS-C report, and the time of receipt of the ADS-C report by TAAATS. Whilst there *may* be other delays (other than transmission) within this time interval, the error was deemed to be negligible.

3.2 For the purpose of this analysis, transmission delays of greater than 500 seconds were deemed to be 'major' delays. Transmission delays of between 300 seconds up to and including 500 seconds were deemed to be 'minor' delays. ADS-C reports subject to minor and major delays were stored for further processing. The aircraft registration was then extracted from these ADS-C reports which enabled the determination of the aircraft type and aircraft operator, by reference to a separate database. This information was also stored, to allow any trends to be determined.

3.3 The ADS-C data was then used to generate maps, with three different colours being used to differentiate between the basic reports, and reports with 'minor' or 'major' delays. The types of maps generated included:

i) Separate overviews of *all* ADS-C reports received by YBBB and YMMM;
ii) Overviews of ADS-C reports downlinked by each aircraft type; and
iii) Overviews of ADS-C reports downlinked by each airline.

3.4 Even before this all this data was forwarded to the FIT CRA for analysis, it was readily apparent that the maps supported the intuitions that controllers had with regard to the problems being related to location and aircraft type.

3.5 The maps generated for YBBB for February 2004 are included as attachments to this working paper. The sample size of the data used to generate these maps was:

ADS-C basic reports analysed: 27968
ADS-C reports with minor delay: 105
ADS-C reports with major delay: 138

Note. *It should be mentioned that not <u>all</u> of the delayed ADS-C reports displayed on these maps are necessarily related to the same problem.*

4. Results

4.1 After studying all the data, the FIT CRA determined that there was certain equipment from a specific avionics manufacturer that was common to the aircraft types suffering these problems. This equipment is known as the Satellite Data Unit (SDU).

4.2 It appears that the problem relates to the transition of the aircraft from one satellite 'spot beam' to another. This problem causes the avionics to "buffer" data link downlink messages (ADS-C & CPDLC), and to transmit the contents of the buffer at a later time. Data link uplink messages appear to be unaffected by this problem. The geometry of how these spot beams overlap explains why the problem is sometimes 'direction specific'.

4.3 The FIT CRA has contacted the avionics manufacturer to investigate this fault, but the time frame to identify the specific problem and to implement a fix is unknown.

5. Recommendation(s)

5.1 Air Traffic Service Units (ATSUs) and airline operators are encouraged to:

- Implement procedures to ensure the reporting of data link failures and idiosyncrasies. The collation of reports from a number of sources in a central location may be invaluable in identifying wide spread problems.

- Note the problems encountered and be aware of the problems outlined in this paper when implementing data link systems or considering the use of ADS-C outside VHF data link coverage for the application of reduced separation standards.

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For more information contact:

Adam Watkin
adam.watkin@airservicesaustralia.com

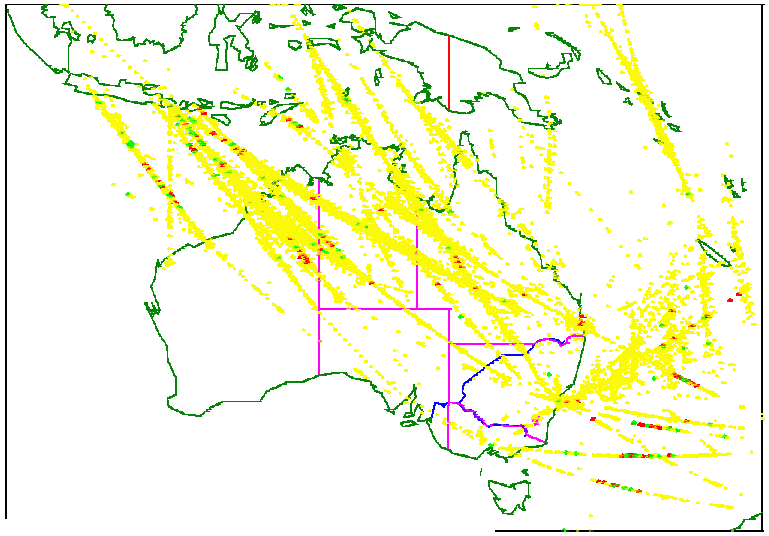


Figure 0 All ADS reports - YBBB - Feb 2004

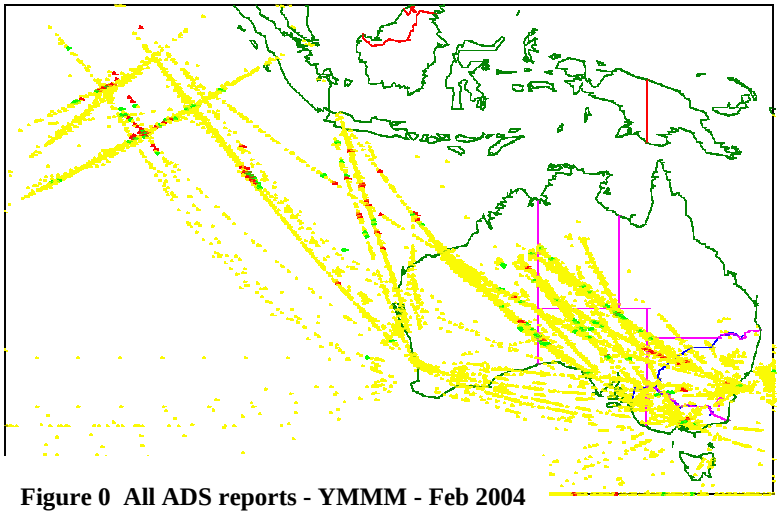
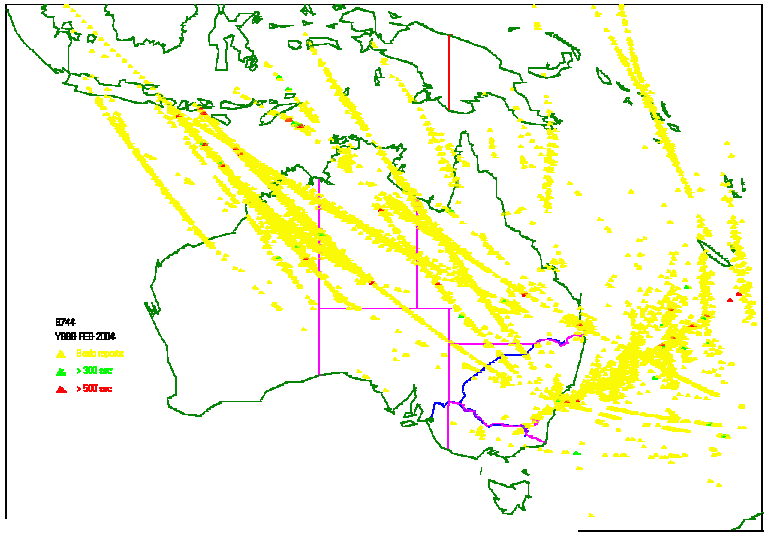


Figure 0 All ADS reports - YMMM - Feb 2004



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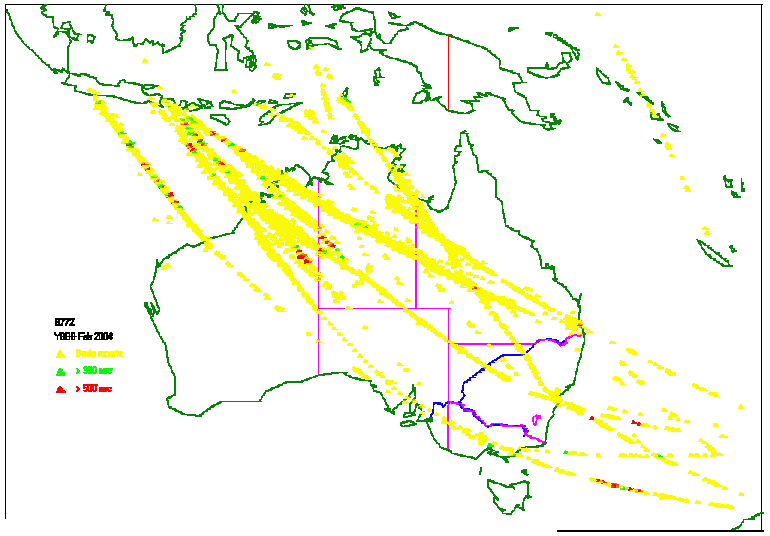

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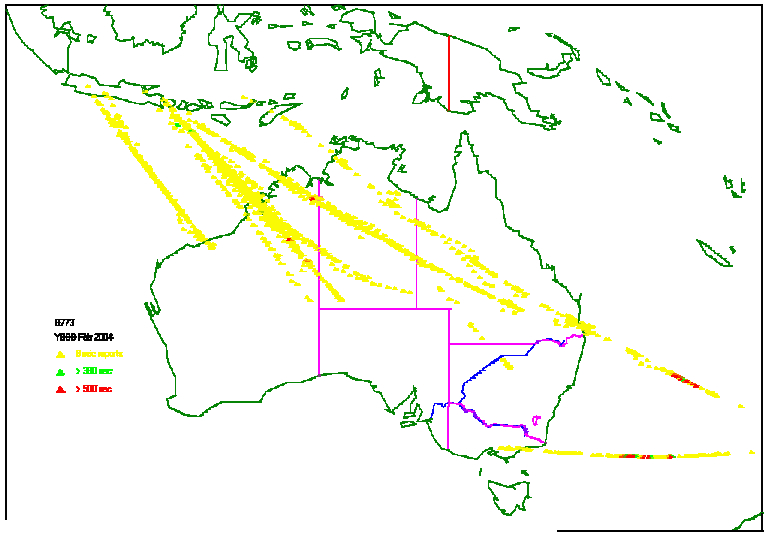

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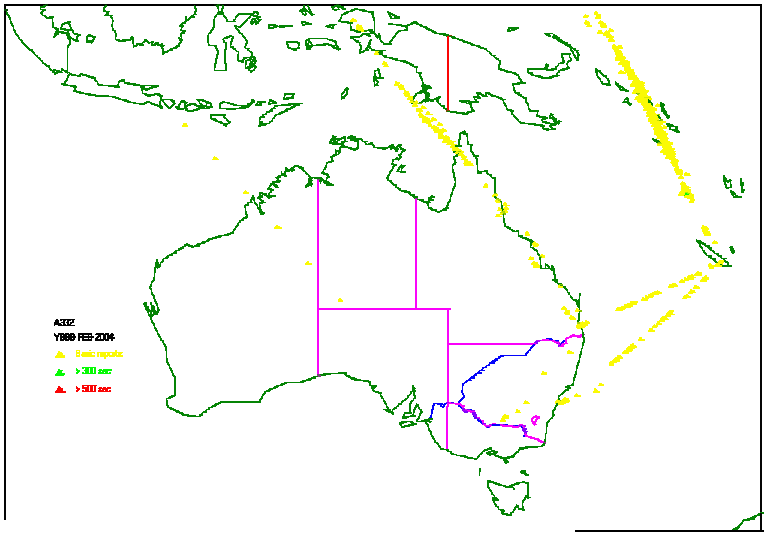

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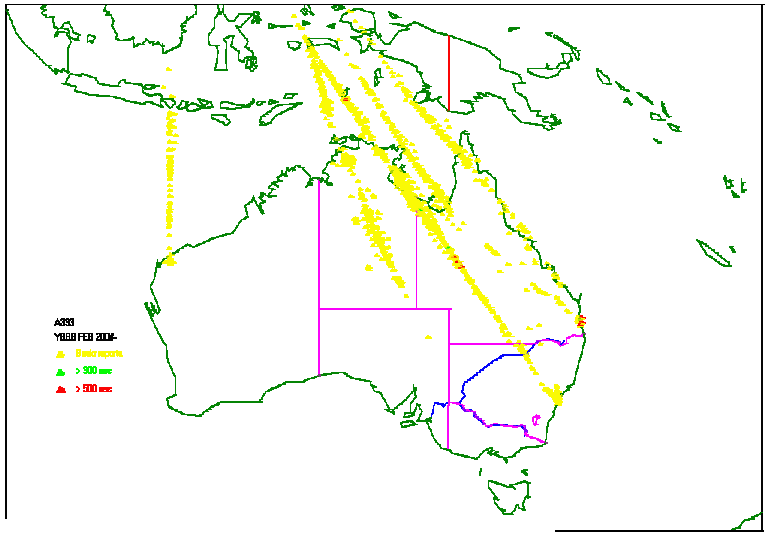

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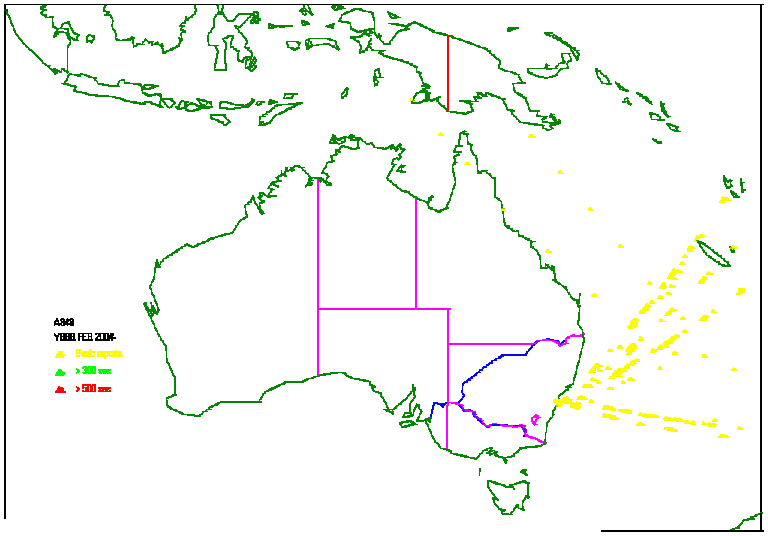

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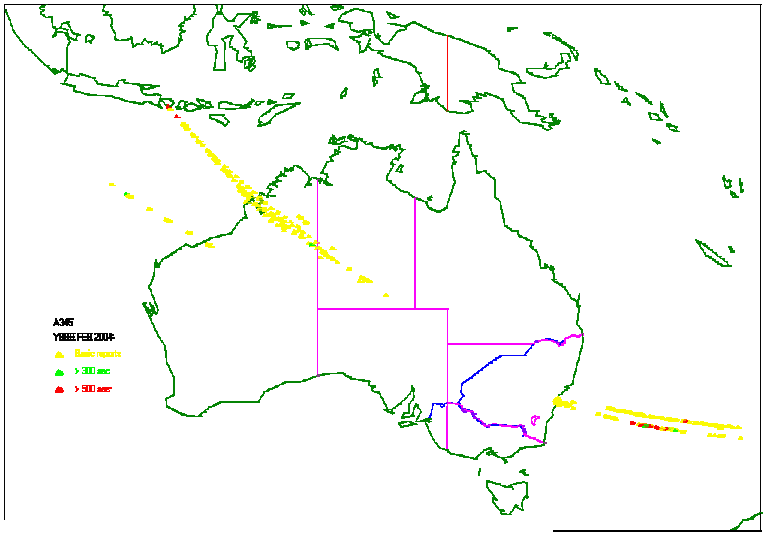

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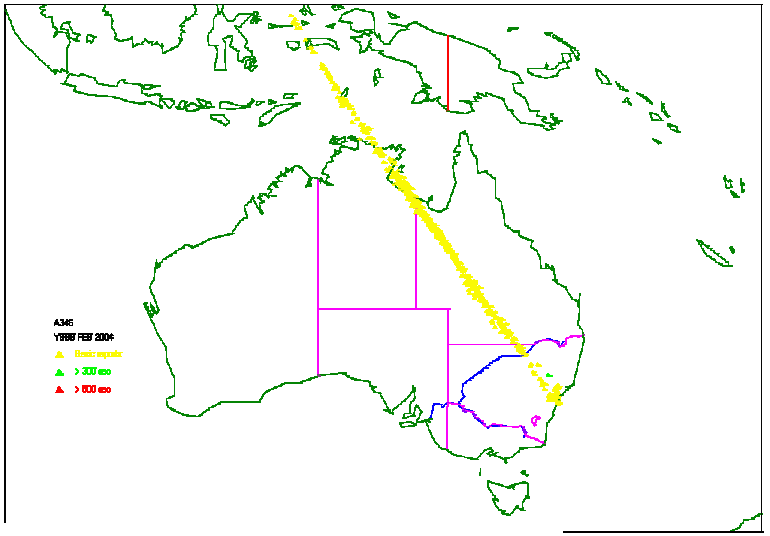

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