FANS Interoperability Team Meeting
(FIT/20)

Auckland, New Zealand
26 – 27 February 2013

Agenda Item 5: Working Papers

CPDLC and ADS-C Data Link Performance Monitoring for the Brisbane FIR

Presented by Airservices (Australia)

SUMMARY

This paper provides observed performance measures as specified in the Global Operational Data Link Document (GOLD) from the operational data collected in the Brisbane FIR. This analysis includes performance of the Controller Pilot Data Link Communication (CPDLC) and Automatic Dependent Surveillance – Contract (ADS-C). Data was from the entire 2012 calendar year.

1. INTRODUCTION

1.1 This paper provides observed performance measures from the operational data link system in the Brisbane FIR. The purpose of this paper is to present the most recent observed performance of the data link system. Data was collected during the interval 1 January 2012 to 31 December 2012.

1.2 The performance data observed from the Controller Pilot Data Link Communications (CPDLC) and Automatic Dependent Surveillance - Contract (ADS-C) systems are measured against the appropriate Required Communication Performance (RCP) and Required Surveillance Performance (RSP) specification to demonstrate that safety objectives which rely on the communications infrastructure can be met by the aircraft and ground systems.

1.3 This paper presents the data link performance by media type and by operator with a break down by monthly performance

1.4 The Global Operational Data Link Document (GOLD) provides the guidance material describing the required data points from the FANS 1/A aircraft communications addressing and reporting system (ACARS) messages. The GOLD also describes the calculation process for the actual communication performance (ACP), actual communication technical performance (ACTP), pilot operational response time (PORT), and surveillance latency.

2. DISCUSSION

2.1 Figure 1 presents the ACP measurement for the messages sent within the Brisbane FIR by media type (Satellite and VHF) during the time period. The numbers of CPDLC messages included in the analysis are shown in the legend of Figure 1. There were 90719 satellite, 57970 VHF, and 149798 messages in total. The ACP for CPDLC messages sent via Satellite and VHF messages meet the 95 percent criterion but fall below the 99.9 percent criterion.

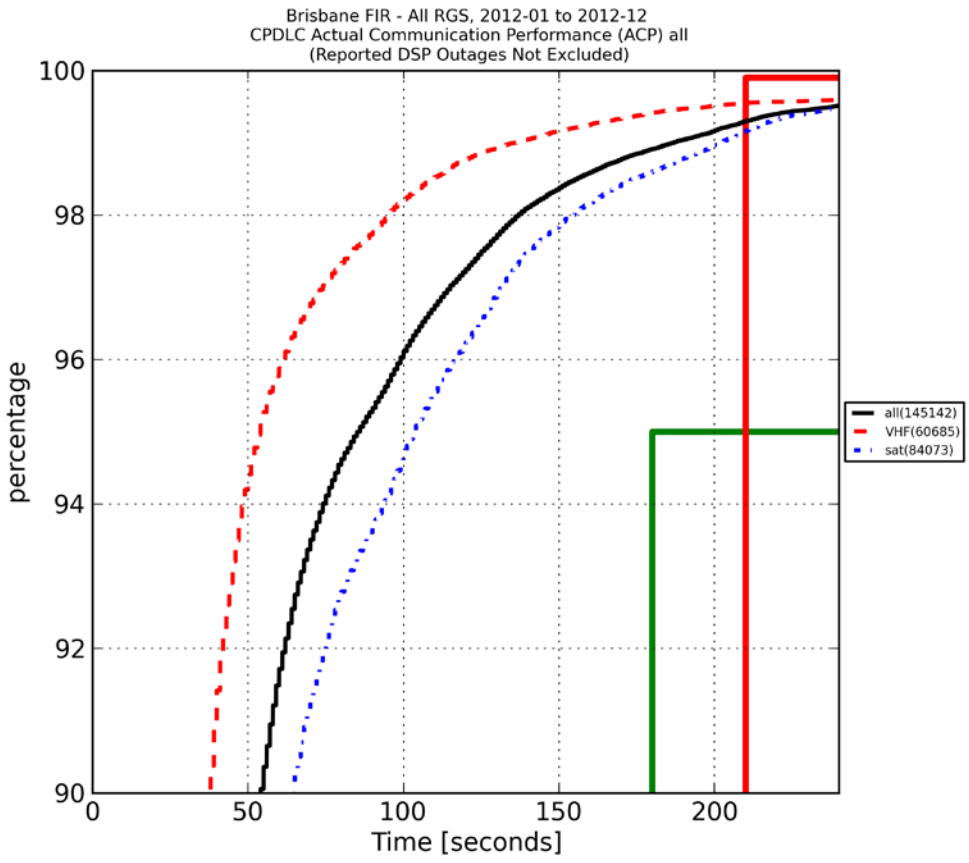

Figure 1: ACP – Brisbane FIR by Data Link Media Type.

2.2 Figure 2 presents the ACTP measurements for messages sent within the Brisbane FIR by media type (Satellite and VHF) during the time period. The number of messages is shown in the legend. Figure 2 shows that data link messages sent via VHF and satellite meet the 95 percent ACTP criterion but not the 99.9% criterion.

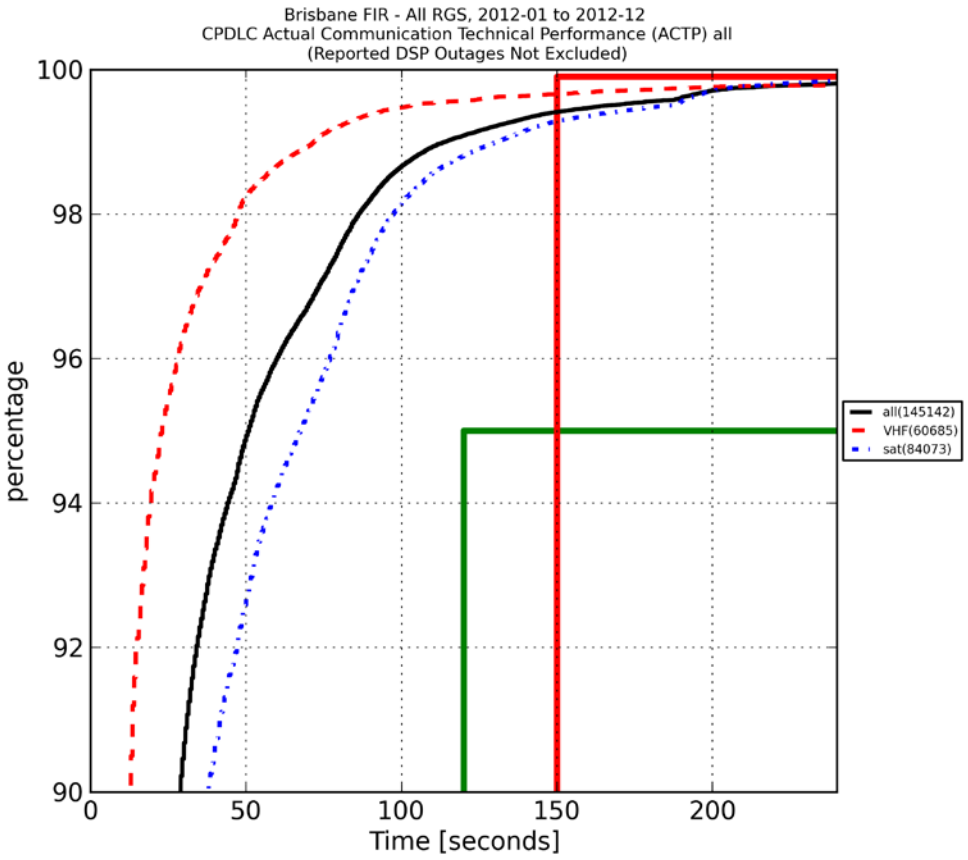

Figure 2: ACTP – Brisbane FIR by Data Link Media Type.

2.3 Figure 3 presents the ADS-C Downlink Latency measurements for messages sent within the Brisbane FIR by media type (Satellite and VHF) during the time period. The number of messages is shown in the legend. Figure 3 shows that data link messages sent via VHF and satellite meet the 95 percent ACTP criterion but not the 99.9% criterion.

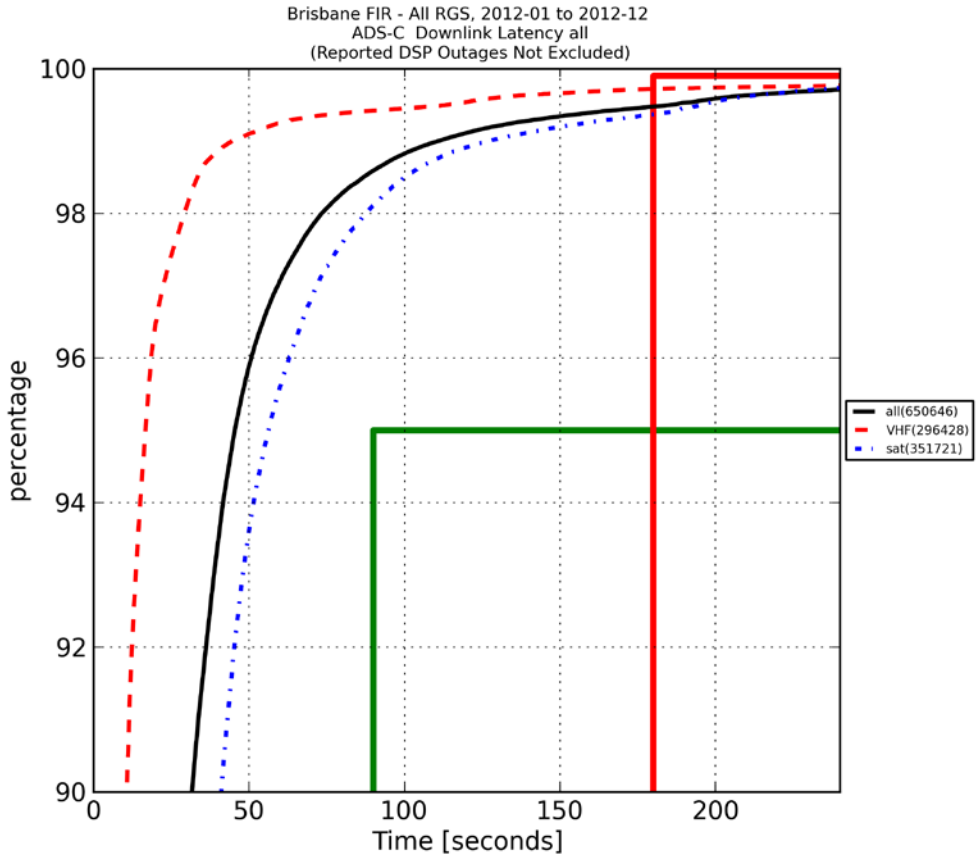

Figure 3: ADS-C Downlink Latency– Brisbane FIR by Data Link Media Type.

2.4 Figure 4 presents the Brisbane FIR ACP (satellite) by month. The months and the number of messages are indicated in the legend.

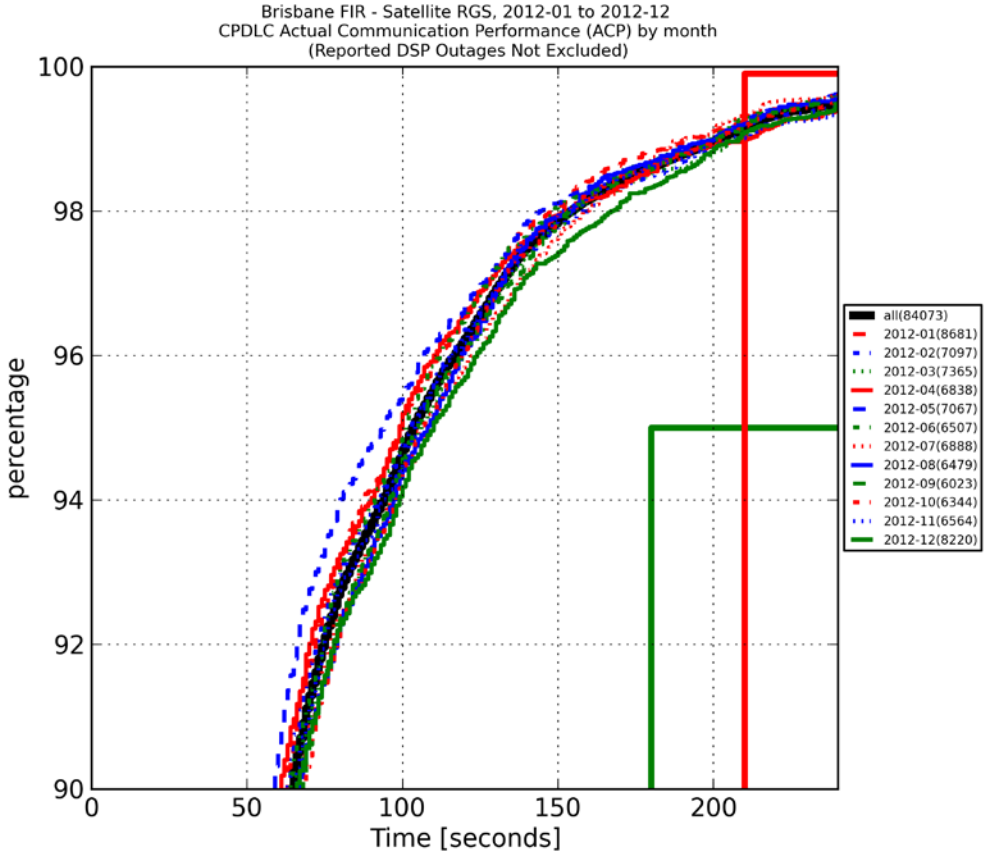

Figure 4: ACP performance for Brisbane FIR by month (SAT RGS only).

2.5 Figure 5 presents the ACTP Brisbane FIR (satellite) performance by month. The months and the number of messages are indicated in the legend.

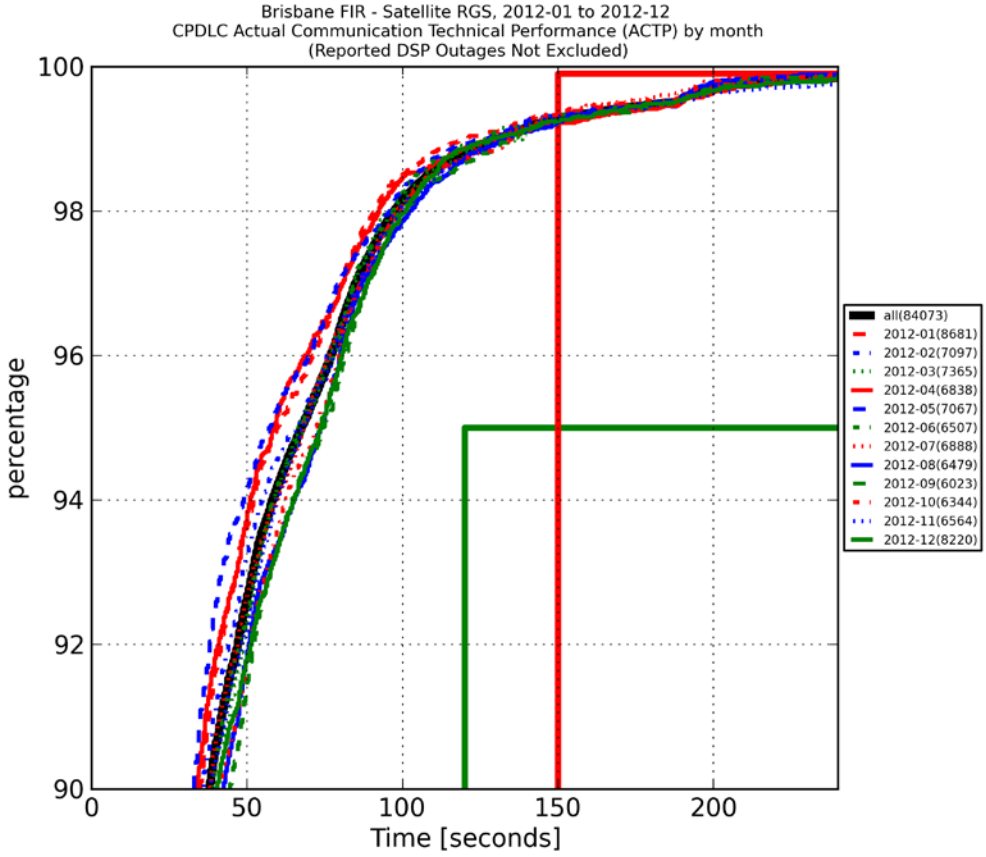

Figure 5: ACTP for Brisbane FIR by month (SAT RGS only).

2.6 Figure 6 presents the ADS-C Brisbane FIR (satellite) performance by month. The months and the number of messages are indicated in the legend.

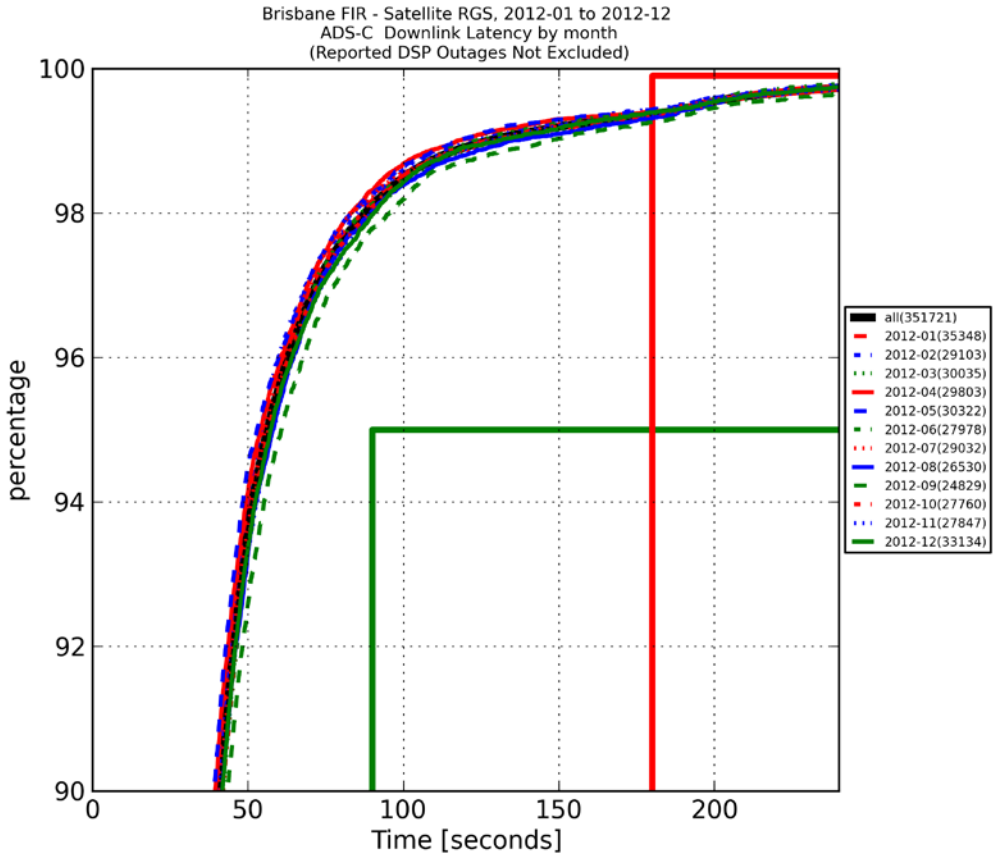

Figure 6: ADSC Downlink Latency for Brisbane FIR by month (SAT RGS only).

2.7 Figure 7 presents the ACP Brisbane FIR (HF) performance by month. The months and the number of messages are indicated in the legend. The RCP 400 and RSP 400 criteria are used in Figures 7 through 9 for the HF data link performance targets. Note in Figure 7 that there is limited data for each month however the summary data "all" does indicate a firm enough trend which fails to meet the 95% criterion.

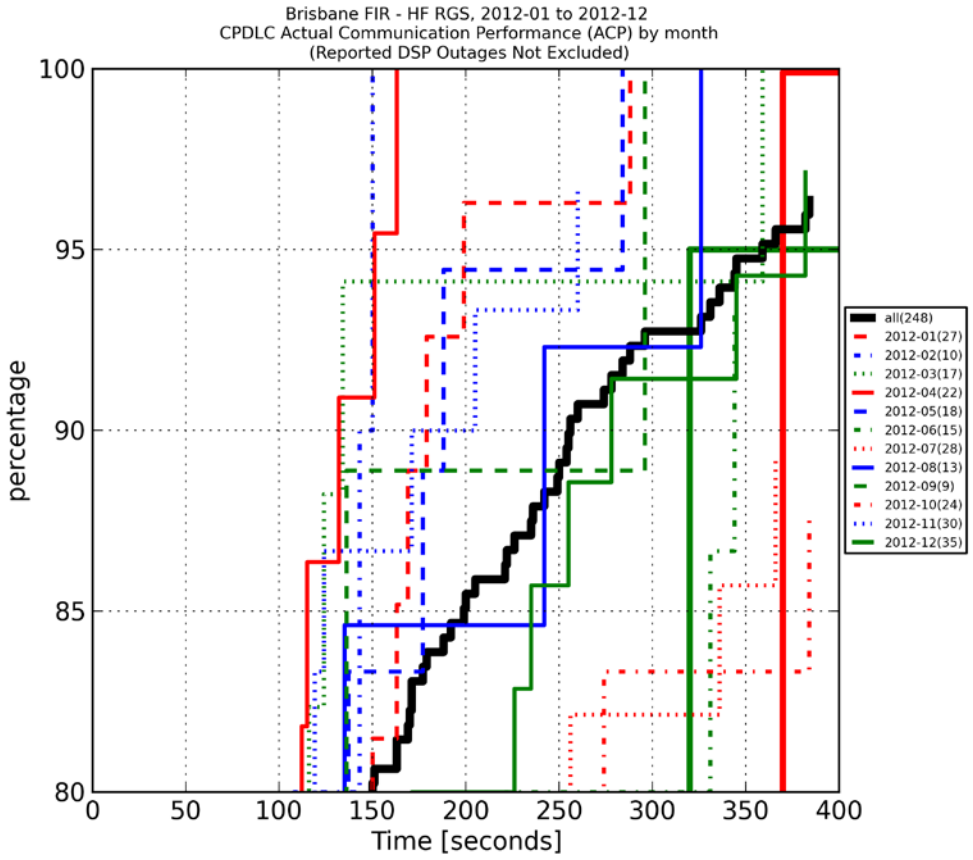

Figure 7: ACP by month for Brisbane FIR (HF RGS only).

2.8 Figure 8 presents the ACTP HF performance by month. The months and the number of messages are indicated in the legend. Note in Figure 8 that there is limited data for each month however the summary data "all" does indicate a firm enough trend which just fails to meet the 95% criterion.

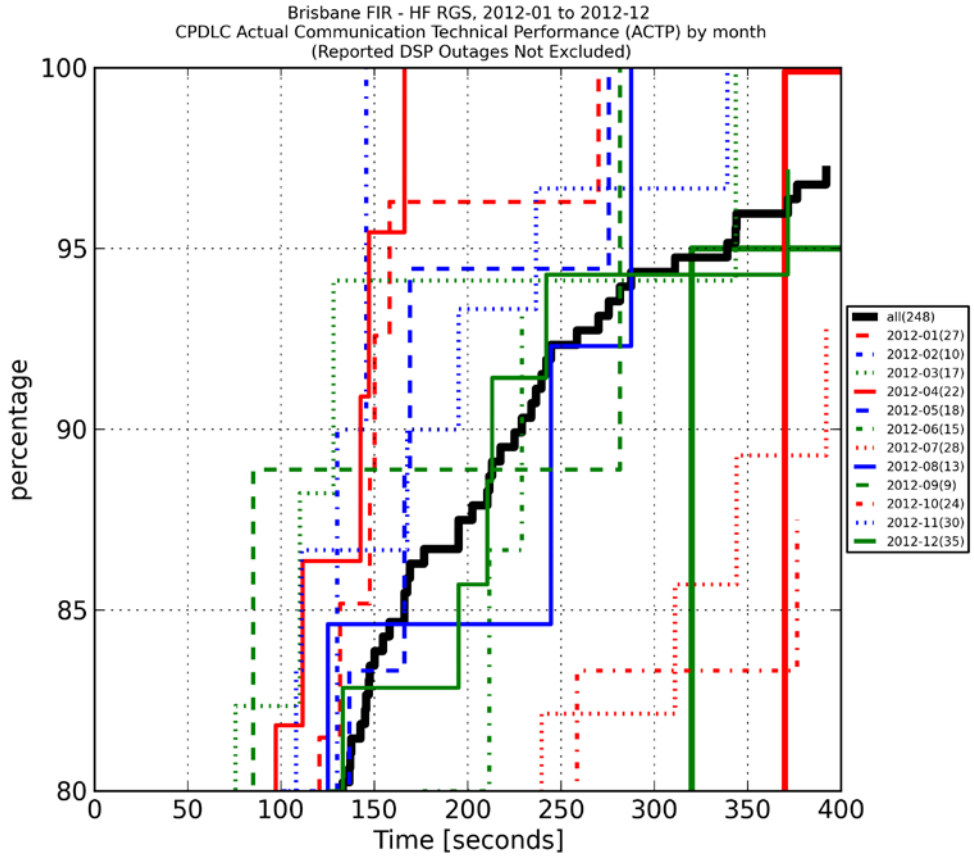

Figure 8: ACTP by month for Brisbane FIR (HF RGS only).

2.9 Figure 9 presents the ADS-C HF performance by month. The months and the number of messages are indicated in the legend. Here the summary performance "all" just fails to meet the 300 second, 95% criterion. There is sufficient data in some months for these to clearly fail to meet the 95% criteria.

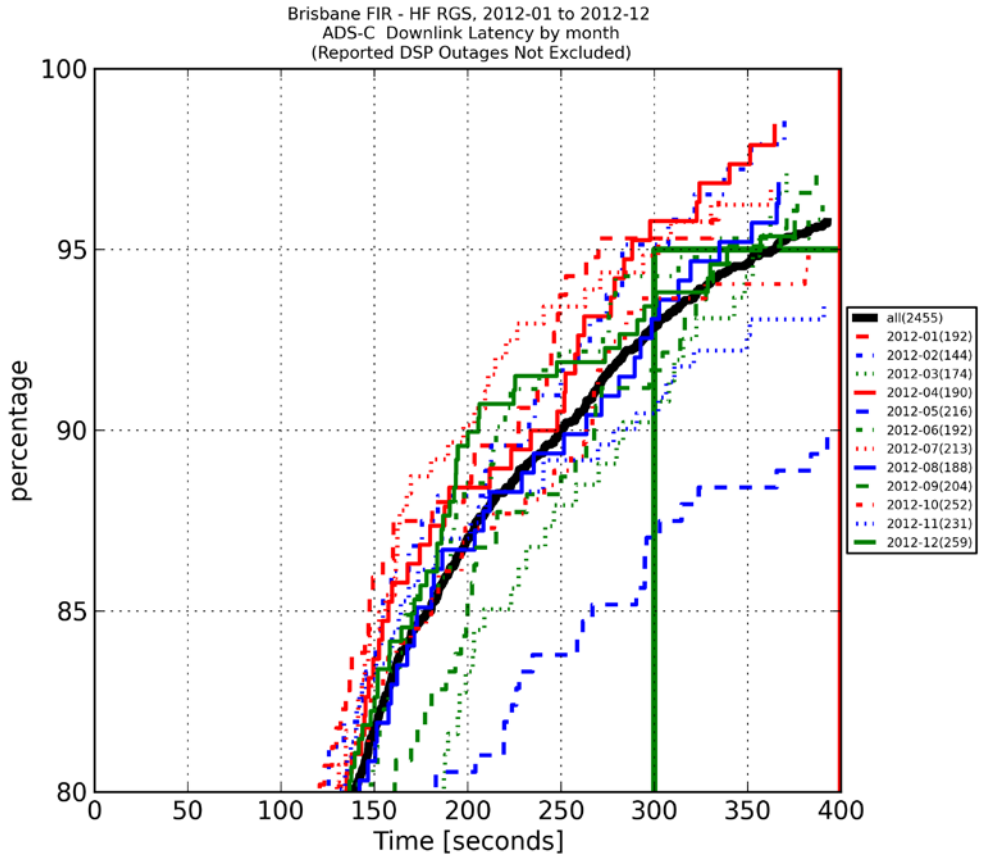

Figure 9: ADS-C Downlink Latency by month for Brisbane FIR (HF RGS only)

2.10 Figures 10 through 13 show the ACP, ACTP, PORT and ADS-C downlink latency charts by operator for the time periods shown. Figures 10 through 13 include only satellite data link communications and represent observed performance in the Brisbane FIR. Again, the numbers of messages observed during each month by operator are shown in the legend key of each figure. These top 18 operators contributed 87 percent of the message counts were chosen. The identifying information for the operators is desensitized in the figures.

2.11 Figure 10 shows the satellite ACP by operator for the Brisbane FIR.

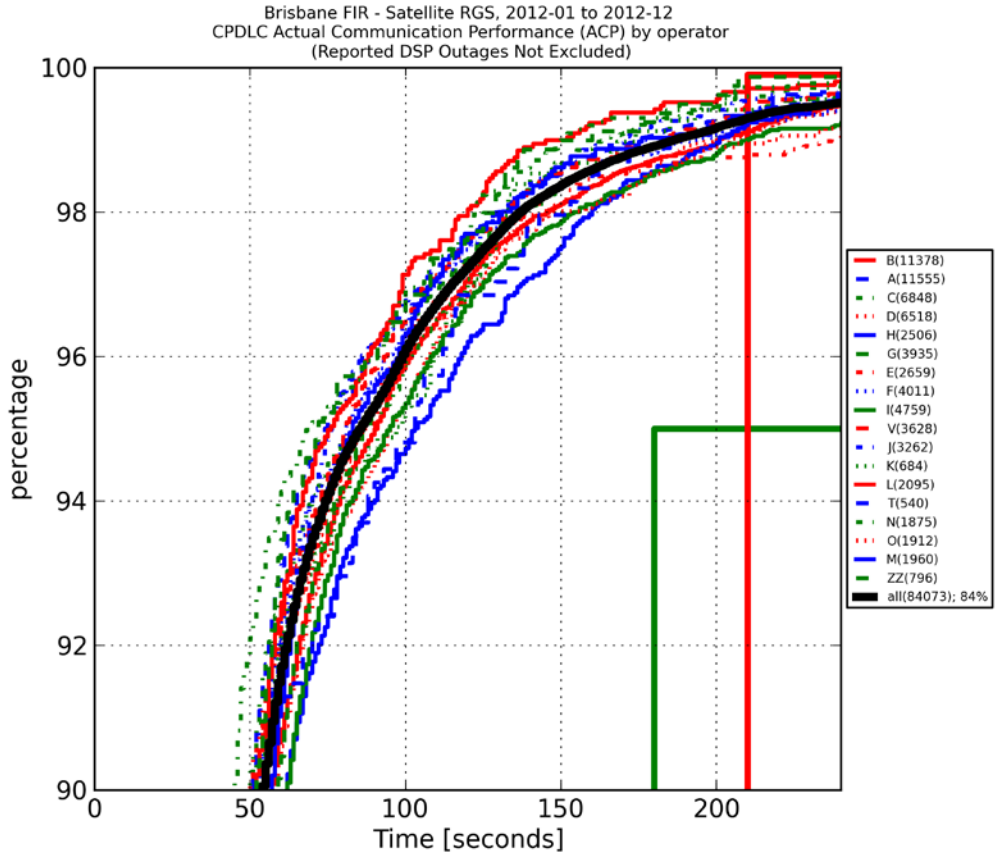

Figure 10: ACP – Brisbane FIR by Operator (SAT RGS only)

2.12 Figure 11 shows the satellite ACTP by operator for the Brisbane FIR.

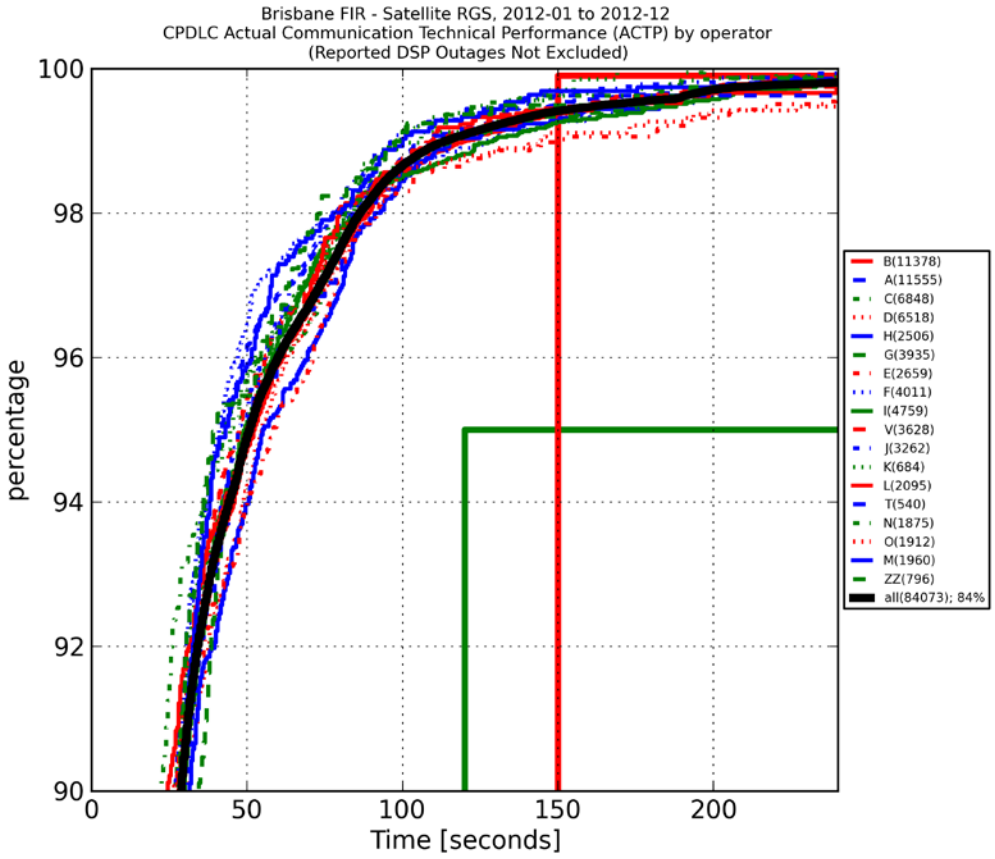

Figure 11: ACTP – Brisbane FIR by Operator (SAT RGS only)

2.13 Figure 12 shows the satellite ADS-C Downlink Latency by operator for the Brisbane FIR.

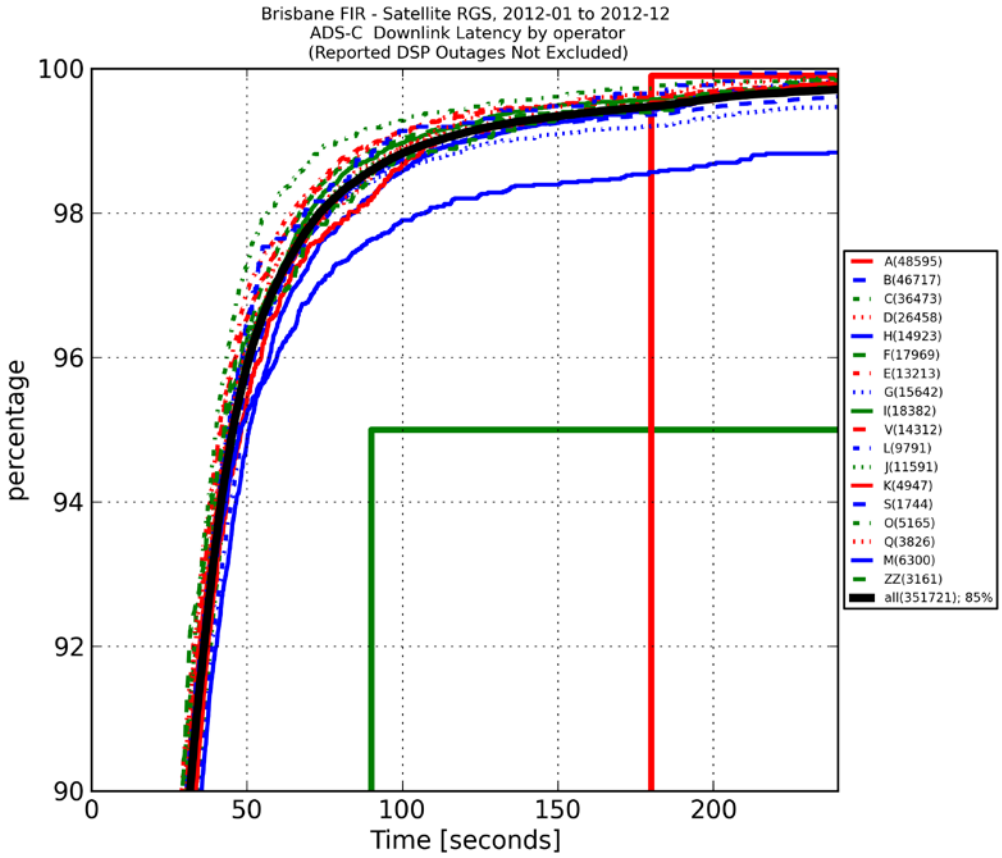

Figure 12: ADS-C Downlink Latency – Brisbane FIR by Operator (SAT RGS only)

2.14 Figure 13 shows the satellite PORT by operator for the Brisbane FIR.

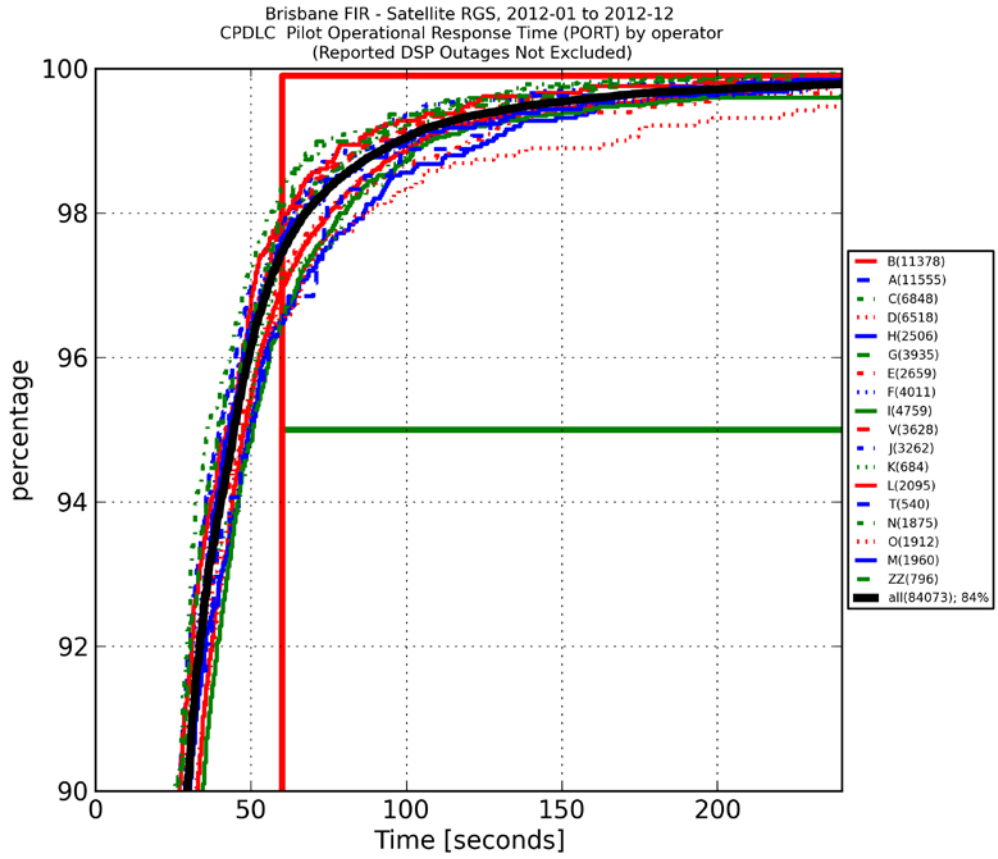

Figure 13: PORT – Brisbane FIR by Operator (SAT RGS only)

2.15 The Brisbane FIR results usually meet the 95% criterion. The 99.9 % results were not achieved however this appears unrealistic in light of the consistency in the data. Most data did however reach an equivalent 99% performance level for the equivalent time.

2.16 The current results do not have the reported outages removed. Outages will be fully treated in future analyses. Previous work indicates that this usually has little effect on the graphs.

2.17 Further work is being done to study this data including:

a) finding improved methods to represent the data (such as the time-series Figure 9b)
b) finding statistical tests to identify outlying operators and aircraft which may be the cause of the majority of poor performance
c) finding statistical tests to determine the confidence intervals of results at the tail-ends of the distributions (ie the 99.9% levels)

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) Review and comment on the information contained within this paper and the accompanying power point presentation file.

4. Appendix

4.1 Some alternative methods of plotting results are as follows. **These are given for interest only and will be explored further for the next meeting.** Figure 4.1 shows the standard method of reporting ACP as a cumulative distribution function (cdf).

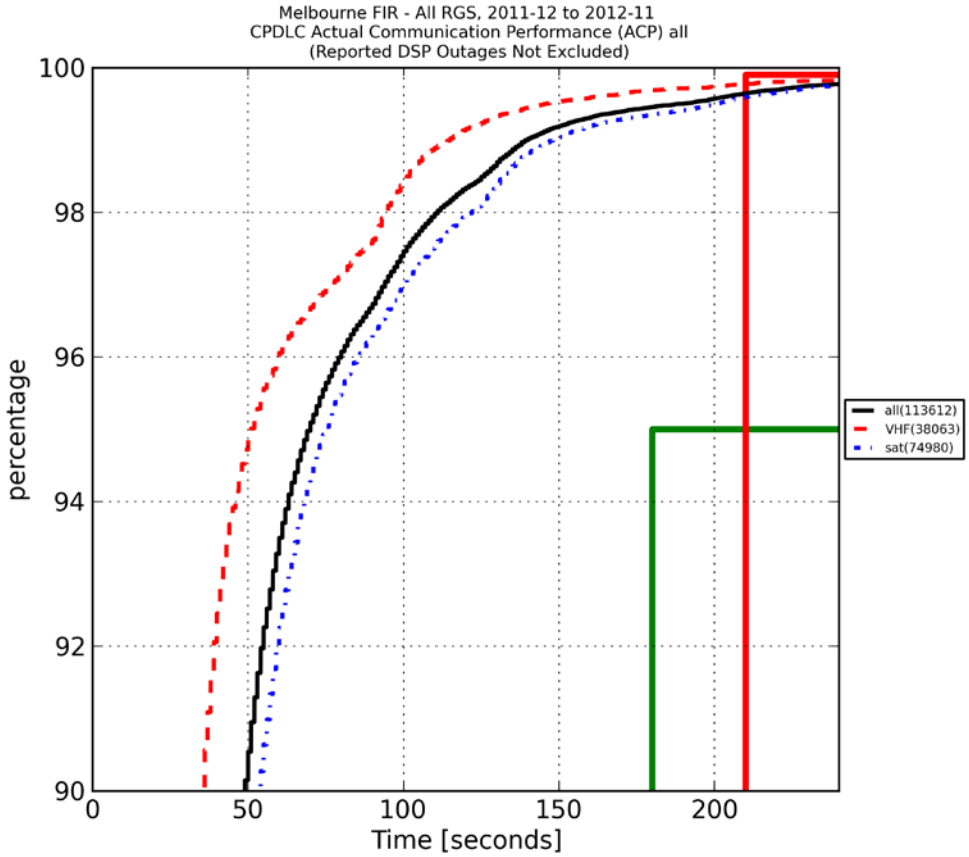

Figure 4.1: A standard percentage cumulative distribution plot of data. Here it is ACP.

4.2 Figure 4.2 shows a breakdown of ACP into counts by the communication means of VHF, Satellite and HF. Note that the y-axes have different scales and the x-axis is **the logarithm of the time.** The plots are histograms of the counts in a set of time intervals.

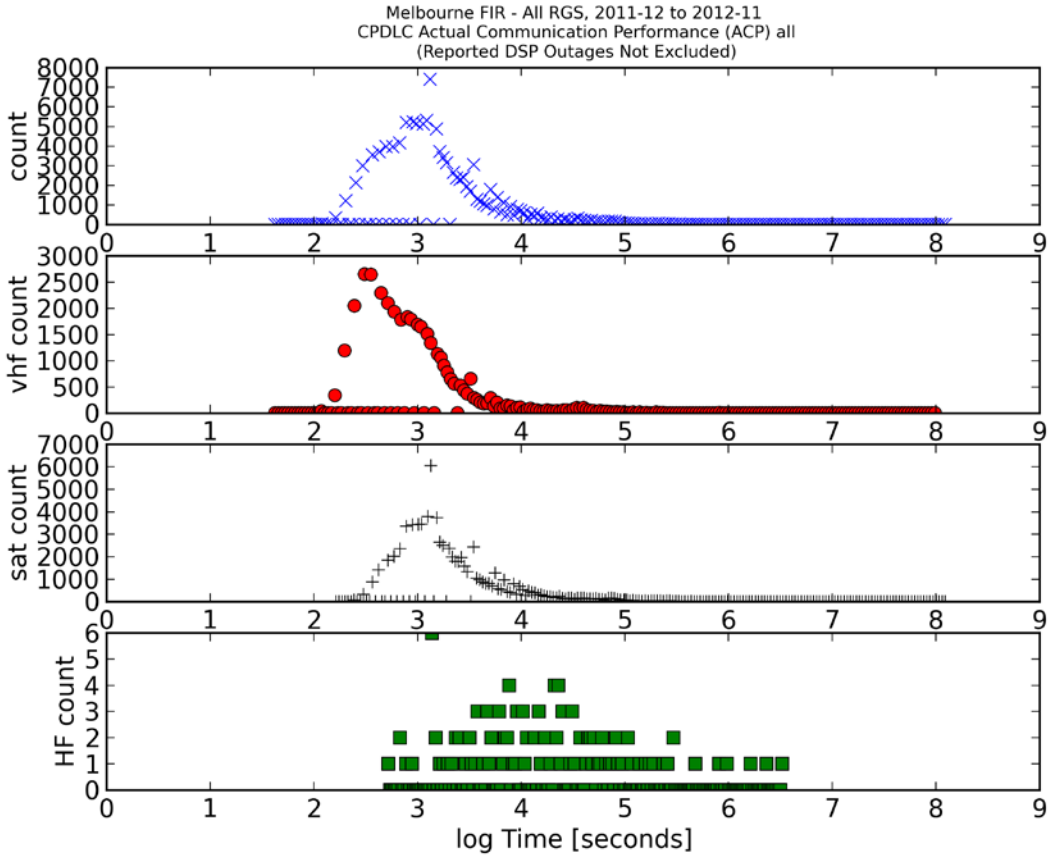

Figure 4.2: ACP as a histogram (counts for each time interval) for VHF, Satellite and HF. Note that the time is natural logarithmic to show all the times appearing in the data.

4.3 Figure 4.3 shows counts for the different communication means. The plot is the same as Figure 4.2 except that now **both axes are logarithmic**.

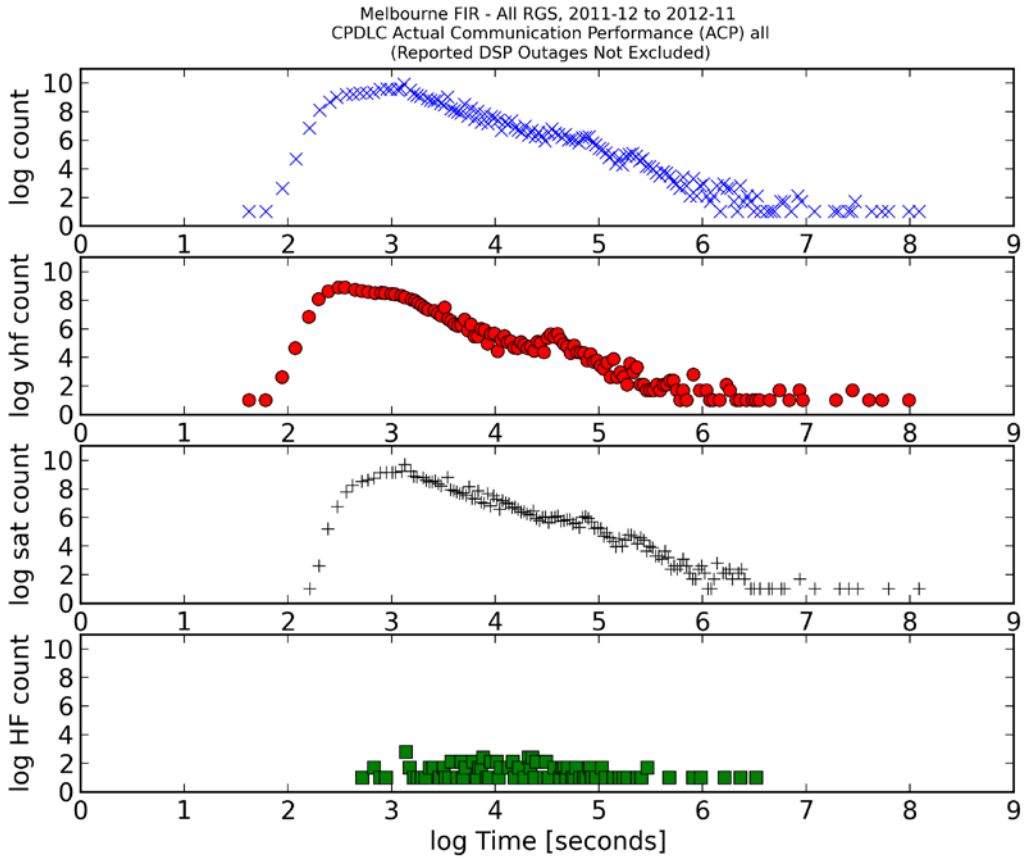

Figure 4.3: ACP as a histogram (counts for each time interval) for VHF, Satellite and HF. Note that the time is natural logarithmic to show all the times appearing in the data, and the y-axis is logarithmic to show more detail in the distribution's long tail.

4.4 Figure 4.4 shows the overall result for ACP for all communication media as a time-series. This version allows trends in data to be clearly seen and allows more months to be plotted. The separate results for satellite, HF, VHF data could also be shown on the same plot with undue clutter. This graphical method only shows the key results (the 180 and 210 second criteria) and the levels they must exceed (95%, 99.9%).