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**Agenda Item 7: ANSP Monitoring**

# POST IMPLEMENTATION MONITORING DEVELOPMENT OF RCP AND ADS LATENCY

(Presented by Airways New Zealand)

**SUMMARY**

This paper provides a further update on RCP monitoring by Airways New Zealand. The paper provides information on current measured performance together with information on some of the analysis that has been undertaken when identifying performance issues. We intend to use this development work and any feedback received during the process to generate the draft GOLD Appendix D covering FANS1/A post implementation monitoring.

## 1. INTRODUCTION

1.1 Airways New Zealand has been developing FANS1/A monitoring to the Oceanic SPR standard since October 2007. We previously reported on this development at ISPACG22 FIT/15 in WP-04. WP-04 discussed the methodology used to extract the Actual Communications Performance (ACP) and Actual Communications Technical Performance (ACTP) for CPDLC and the latency for ADS reports and provided illustrations of the type of performance data that was extracted.

1.2 This working paper discusses our current thoughts regarding post implementation monitoring and has been prepared to generate discussion on this topic as we plan to use the views expressed in this paper to further develop the draft GOLD Appendix D which will provide global guidelines for FANS1/A post implementation monitoring.

## 2. DISCUSSION

2.1 Our experience in the last 12 months has continually emphasized the importance of monitoring by individual ANSP of the FANS1/A performance in their airspace. Performance differences have been identified between the same airline fleets in different airspaces. Two recent examples of this are the lower than expected CPDLC performance from the UAE A345 and B773 fleets on westbound Tasman routes, and the performance of the A388 fleets which are showing lower than expected performance in NZZO when compared with other Airbus fleets operating in our airspace. However, with the A388 Air Services Australia are reporting normal performance in their airspace. The amount of analysis time needed to extract these performance differences is currently quite extensive as a lot of manual analysis is necessary. The development of analysis tools that will automate the majority of this work is seen as an important prerequisite for the type of monitoring that will be needed.

2.2 We consider most FANS1/A problem reports derived from RCP monitoring will be generated by data analysis at individual ANSP. It is the ANSP that has immediate access to reported issues as they occur, and probably more importantly has the local knowledge and resources needed to review the data for any degraded performance noticed in their airspace. We feel that a regional CRA may struggle to do the type of analysis needed both from the availability of resources required to do the analysis and also a lack of local knowledge. The regional CRA would in our view be better suited to aggregating actual reported RCP performance data from individual ANSP to derive regional performance data figures and issues that may be viewed by other regions. If required global aggregation of this regional data could be easily achieved.

2.3 We propose that each ANSP will provide the CRA with monthly performance data for both ADS and CPDLC in the form of a comma delimited text file. Refer Appendix A for an explanation of the data that is proposed for inclusion in these files. Regional CRA should agree these reporting requirements with each ANSP and will maintain a set of regional performance statistics aggregated from the individual ANSP reports. A proposed set of regional performance statistics is attached at Appendix B.

2.4 Our RCP monitoring at an ANSP level is based on a monthly analysis of FANS1/A data. For ADS we monitor the downlink latency using all received ADS reports from which we can extract an aircraft timestamp and for CPDLC we measure ACTP, ACP, and Crew Response for all sent uplink messages that receive both MAS and a WILCO response. For CPDLC we initially just looked at intervention type uplinks that received a WILCO response because in the application of reduced separation standards you are interested in the performance of the communications media in an intervention type situation. We have modified this to capture any CPDLC uplink that receives a WILCO response e.g. by including frequency contact/monitor instructions, mainly because we needed more data on our short sector routes and these were the type of messages that are guaranteed. An analysis of the performance differences between all CPDLC uplinks with a WILCO response and only intervention type clearances showed little difference in the results obtained. The overall aim of our analysis to date has been to determine the actual performance of aircraft against the standard and to detect any variations from the standard to enable corrective actions to be initiated. This reflects a culture of continuous performance improvement which is where we want to be.

2.5 Currently, we are monitoring on a monthly basis individual airline fleet performance for both CPDLC and ADS. For both applications we have been concentrating on data received via SATCOM rather than VHF as SATCOM performance is of main interest in our FIR. However, we are starting to look at the effect of HFDL on performance now that we have the A388 operating long route segments in our airspace. Pure VHF performance is well within the requirements and we have spent little time in looking at this. Performance analysis can be done for any media type and for all media combined. A typical CPDLC ACTP analysis for a particular aircraft company and type is illustrated below in Figure 1. An ADS latency assessment for an airline aircraft type uses a graph of similar presentation. These graphs provide a clear visual display of month to month performance and aggregated performance.

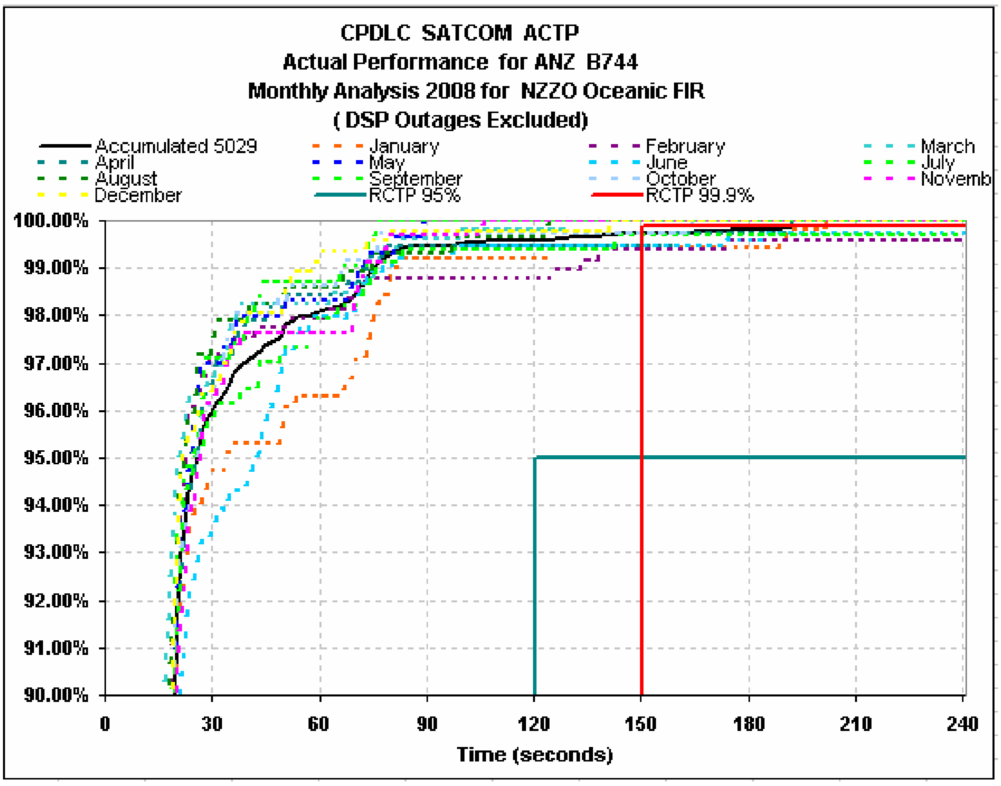


**Figure 1: Typical monthly ACTP analysis for an airline type pairing in 2008**

2.6 These monthly results are then consolidated into a year to date aggregate for each airline and aircraft type pairing and can be done for any type of transmission media or combination. Where deviations are detected from the normal expected performance for a particular aircraft type further analysis may be completed for each aircraft tail in a particular fleet in order to determine if one aircraft is responsible for the degraded fleet performance.

2.7 A typical consolidated summary for a year to date ADS SATCOM is shown in Figure 2 below and some observations on the performance from different types observed are noted on Figure 2 and are listed below:

Note 1: The performance seen here on airline III B777 is typical of the degraded performance caused by the known problem with VHF transition areas and the B777. This problem has been identified and fixed and will be available to airlines in the third quarter 2009. The typical performance seen from the B777 when delayed reports caused by VHF transition areas are filtered is illustrated by airline DDD B772 filtered.

Note 2: This is the typical degraded performance seen at an ANSP that is caused by the degraded performance of a "rogue" aircraft in an airline fleet. Observation of the delayed reports on a monthly basis is usually enough to identify the "rogue" tail and enable corrective action to be initiated.

Note 3: a. This is typical performance of the A343 aircraft using high speed ACARS channels.

b. This is typical performance of the A343 aircraft using low speed ACARS channels.

Note 4: Typical performance of B744 fleets. Airline CCC uses the high speed ACARS channel, and airline BBB changed from low speed to high speed channels in August 2008.

Note 5: An example of a lower performing B744 fleet. Airline AAA converted to high speed channel use in July 2008 and we are still investigating why the fleet is only achieving around 90% of messages delivered by 180 seconds.

2.8 These accumulated analysis graphs provide a clear visual indication of the relative performance of the different airlines aircraft types. They provide a very visible representation of where improvement is needed.

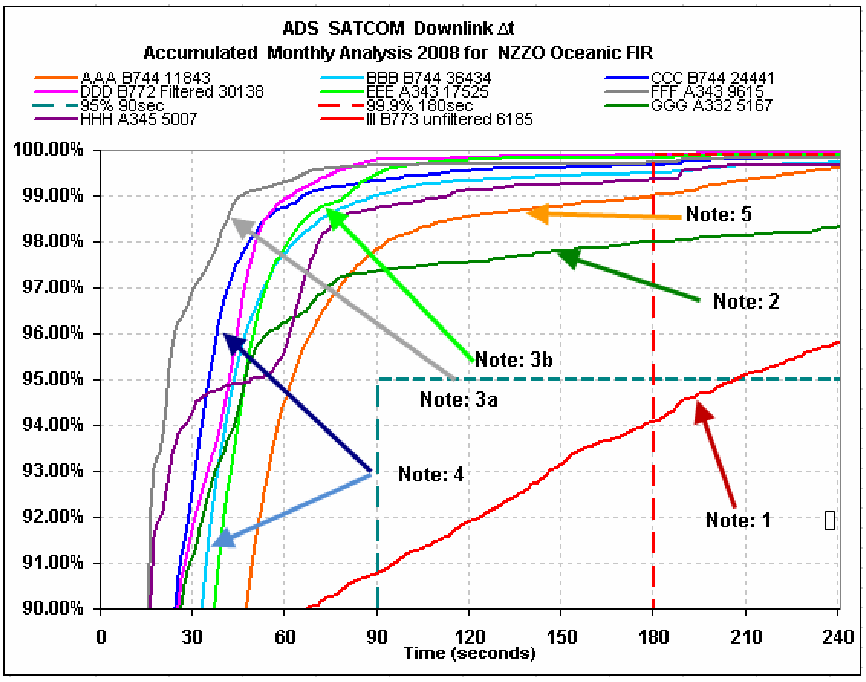


**Figure 2: Accumulated ADS by airline and aircraft type for 2008**

2.9 We have found that some data filtering is required to obtain an accurate representation of actual performance. Filtering is done in a number of cases as follows:

a. Duplicated ADS reports are relatively common from all aircraft types. These are the same reports sent two or three times from the aircraft and if left in will skew the ADS latency data. These duplicated reports are removed from the monthly performance data but would be sent as a separate file to the CRA.

b. We check the extracted data over known periods of system outages that have been notified by the CSP or where our ground system has been down. Any delayed reports during these periods are filtered from the data and again these would be sent in a separate file to the CRA detailing the notified outage and the delayed reports that have been filtered.

c. If a known problem exists with an aircraft type, or a particular tail in a fleet, that is causing degraded performance data e.g. VHF transition on the B777, we will often filter these delayed reports to verify that there is nothing else impacting performance. This filtering would not be done on the monthly reporting data sent to the CRA.

2.10 As a region we have now accumulated a significant amount of data and experience in monitoring FANS1/A CPDLC communication performance and ADS latency and we propose that the methods outlined in this WP be captured in the draft GOLD document.

## 3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) Note the post implementation monitoring described in this working paper and agrees that it fulfils the regional requirements for post implementation monitoring.

b) Recommend that ISPACG support the inclusion of these monitoring requirements in the draft GOLD document.

Appendix A: Monthly reporting format for CPDLC and ADS.

Appendix B: Regional monitoring statistics.

## Appendix A: MONTHLY REPORTING FORMAT FOR CPDLC and ADS

Recording the data points for each CPDLC transaction.

The following data points are recommended as the minimum set that should be extracted from ANSP datalink system recordings to enable RCP analysis and provide sufficient information for problem analysis. This does not preclude individual ANSP from extracting additional data points for their own analysis. To obtain these data points ANSP should note that they will require additional database information to enable the Aircraft Type and Airline to be obtained by correlation to the Tail Number extracted from the datalink recordings. All of the other data points are extracted from either the ACARS header or the CPDLC application message.

1. ANSP - the four letter ICAO designator of the FIR e.g. NZZO.
2. Tail Number – the aircraft tail number in ICAO Doc 4444 Format (no hyphens, packing dots etc) e.g N104UA (Note: Extracted from ACARS header)
3. Aircraft Type Designator – the ICAO type designator e.g B744 (Note: extracted from ANSP database using Tail Number as key)
4. Airline Designator – the IATA designator for the airline. e.g UAL (Note: extracted from ANSP database using Tail Number as key)
5. Date – in YYYYMMDD format. e.g 20081114 (Note: Extracted from ANSP system data recording time stamp)
6. MAS RGS - Designator of the RGS that MAS downlink was received from e.g. POR1 (Note: This is a 3 or 4 letter designator extracted from the ACARS header DT line)
7. OPS RGS - Designator of the RGS that the operational response was received from e.g. AKL1 (Note: This is a 3 or 4 letter designator extracted from the ACARS header DT line)
8. Uplink Time - The timestamp on the uplink CPDLC message sent by the ANSP in HH:MM:SS format e.g. 03:43:25 (Note: Extracted from ANSP system data recording time stamp)
9. MAS Receipt Time - The ANSP timestamp on receipt of the MAS in HH:MM:SS format e.g. 03:43:55 (Note: Extracted from ANSP system data recording time stamp)
10. MAS round trip time in seconds (#9-#8) e.g. 10
11. The Aircraft FMS time stamp in the operational response messages in HH:MM:SS e.g 03:44:15 (Note: Extracted from the ATCmessageHeader timestamp in the decoded operational response message. (See RTCA DO-258A section 4.6.3.3))
12. The ANSP timestamp on the receipt of the operational response in HH:MM:SS e.g. 03:44:45 (Note: Extracted from ANSP system data recording time stamp)

13. Operational Message Round trip time (from sending uplink (#8) to receipt of operational response (#9) in seconds e.g. 80

14. Downlink Response Transit time in seconds (#12-#11) e.g. 30

15. Uplink Message Elements (all uplink message element numbers preceded by U encapsulated between quotation marks with a space between each element) e.g. “U118 U80” (Note: Extracted from the decoded operational uplink that initiated the transaction)

16. Downlink Message Elements (all downlink message elements encapsulated between quotation marks with a space between each element if required) e.g. “D0” (Note: Extracted from the decoded operational downlink)

17. ACTP (Actual communication technical performance in seconds) e.g 35 (Note: truncated to whole seconds)

18. ACP (Actual communications performance in seconds measured as the difference between time uplink sent (#8) to operational response received (#12)) e.g 80

19. PORT (the operational response is received before the MAS as per Figure 2 above Pilot Operational Response Time = ACP (#18) - ACTP(#17) e.g. 45 (Note: Implementers should allow for negative values where.

20. Transaction Completion Indicator – “S” for successful, “F” for failed. The transaction is considered successful if TRN <= 1800 and items 1-19 can be determined. If a transaction fails, all of the data that can be determined should be included in the record.

<u>The data record for each CPDLC transaction</u>
To enable regional analysis and aggregation of data CPDLC transaction data as described above is sent to the regional CRA at agreed intervals (usually monthly) as a comma delimited text file. The format for each record will at minimum contain the 20 data points specified in the previous paragraph. Using the example in the previous paragraph the data record for the transaction described above in comma delimited text file format is:

**NZZO,N104UA,B744,UAL,20081114,POR1,AKL1,03:43:25, 03:43:55,10,03:44:15,03:44:45,80,30,”U118 U80”,”D0”,35,80,45,S**

<u>Recording the ADS-C data points for each ADS-C downlink.</u>

The following data points are recommended as the minimum set that should be extracted from ANSP datalink system recordings to enable an analysis of ADS-C latency and provide sufficient information for problem analysis. This does not preclude individual ANSP from extracting additional data points for their own analysis. To obtain all of these data points ANSP should note that they will require additional database information to enable the Aircraft Type and Airline to be obtained by correlation to the Tail Number extracted from the datalink recordings. All of the other data points are extracted from either the ACARS header or the ADS application message.

1. ANSP - the four letter ICAO designator for the FIR of the reporting ANSP e.g. NZZO.

2. Tail Number – the aircraft tail number in ICAO Doc 4444 Format (no hyphens, packing dots etc) e.g N104UA (Note: Extracted from ACARS header)

3. Aircraft Type Designator – the ICAO type designator e.g B744 (Note: extracted from ANSP database using Tail Number as key)

4. Airline Designator – the IATA designator for the airline. e.g UAL (Note: extracted from ANSP database using Tail Number as key)

5. Date – in YYYYMMDD format. e.g 20081114 (Note: Extracted from ANSP system data recording time stamp)

6. RGS - Designator of the RGS that ADS downlink was received from e.g. POR1 (Note: This is a 3 or 4 letter designator extracted from the ACARS header DT line)

7. Report Type – The type of ADS report e.g PER (Note: Extracted from the Basic ADS group report tag where tag value 7=PER, 9=EMG, 10=LDE, 18=VRE, 19=ARE, 20=WCE)

8. Latitude – The current latitude decoded from the Basic ADS group. The format is "+" for North or "-" for South followed by a decimal number of degrees e.g. -33.456732

9. Longitude – The current longitude decoded from the Basic ADS group. The format is "+" for East or "-" for West followed by a decimal number of degrees e.g. +173.276554

10. Aircraft Time - The time the ADS message was sent from the aircraft in HH:MM:SS e.g 03:44:15. (Note: Decoded from the Basic ADS group timestamp extracted as seconds since the most recent hour. (See RTCA DO-258A section 4.5.1.4))

11. Received Time - The ANSP timestamp on the receipt of the ADS Message in HH:MM:SS e.g. 03:44:45 (Note: Extracted from ANSP system data recording time stamp)

12. Transit Time – The transit time of the ADS downlink in seconds calculated as the difference between #10 Aircraft Time and #11 Received Time i.e 30

<u>The data record for each ADS-C downlink</u>

To enable regional analysis and aggregation of data ADS-C data recorded by an ANSP is sent to the regional CRA at agreed intervals (usually monthly) as a comma delimited text file. The format for each record shall at minimum contain the 12 data points specified in the previous paragraph. Using the example in the previous paragraph the data record for the downlink described above in comma delimited text file format is:

**NZZO,N104UA,B744,UAL,20081114,POR1,PER,-33.456732,+173.276554,03:44:15, 03:44:45,30**

Additional data that an ANSP may wish to include for analysis purposes

ANSP may find that the following additional data may be useful for performance analysis:

1. The aircraft callsign extracted from either the Flight Plan e.g ANZ123 or the AFN log on for the flight e.g NZ123 or the FI line in the ACARS header e.g. NZ0123

2. Direction of flight calculated by the flight data processor and displayed as quadrantal directions N, NE, E, SE, S, SW, W, NW.
3. ADS predicted position latitude and longitude and time if available. (Note: time decoded from the predicted ADS group where timestamp is extracted as seconds since the most recent hour. (See RTCA DO-258A section 4.5.1.4))
4. The estimated position in latitude and longitude of the aircraft when a CPDLC downlink is sent. Calculated by the flight data processor.

Filtered Data

ANSP should send any filtered data to the CRA in separate files. Data records may have been filtered from the main body of data for a number or reasons. These could include:

a. Delayed messages caused by notified system outages that if not filtered would adversely affect observed system performance
b. Duplicated downlinks (usually seen on ADS reports) where the same downlink is received two or three times at the ANSP.

## Appendix B: REGIONAL MONITORING STATISTICS

The following reports could be published by a CRA to reflect overall observed FANS1/A performance for a region against the requirements. The aim is to provide a high level overview for all interested parties, without going into overwhelming detail:

1. Aggregated CPDLC ACTP, ACP, and crew response graphs for all aircraft via all RGS, via SATCOM RGS only, via VHF RGS only, and via HF RGS only. The graphs to include monthly performance data and a year to date aggregate. An example is provided below in Figure 1.

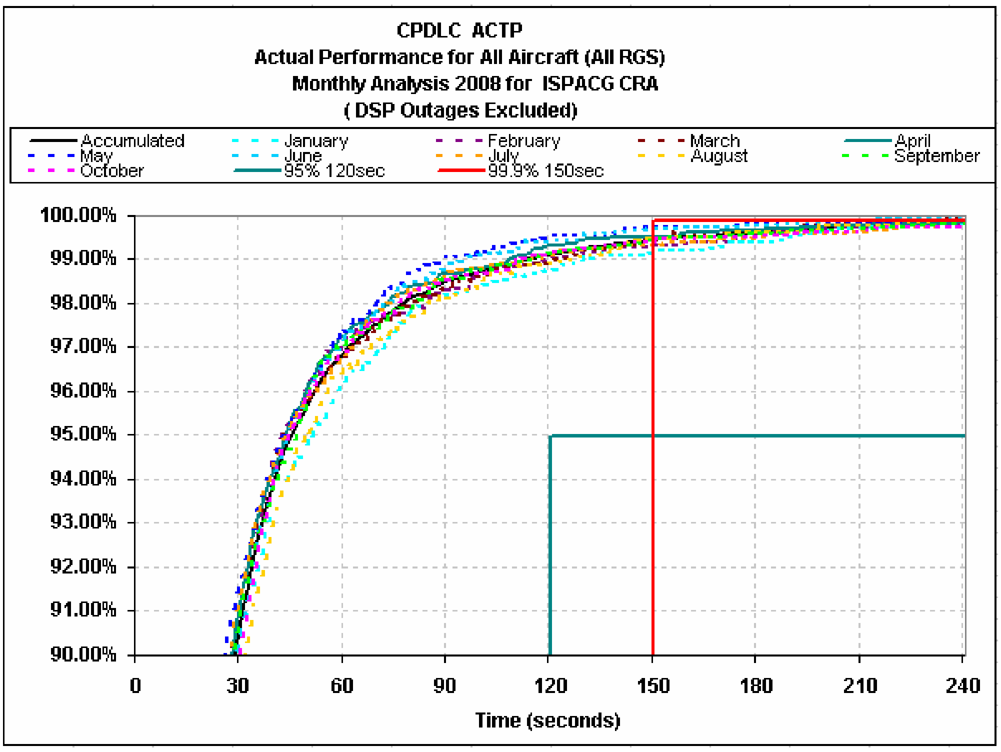


**Figure 1: Example Aggregated CPDLC ACTP for a region all RGS**

2. Aggregated ADS latency graphs for all aircraft via all RGS, via SATCOM RGS only, via VHF RGS only, and via HF RGS only.

3. A report of all current system issues in the region. This would include a listing of problem reports that are currently under investigation by the reporting CRA. On a global scale this would provide other regions the means to see what is occurring in a particular region and may assist these other regional CRA and ANSP in their own investigations.

4. Other CPDLC and ADS latency graphs should be published as required to assist in clarification of identified regional issues for outside parties.