International Civil Aviation Organization

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Bangkok, Thailand, 28 – 29 March 2013

Agenda Item 4: Data Link Guidance Material

GOLD Appendix D – Proposed Changes

(Presented by Airways New Zealand)

SUMMARY

This paper presents the proposed changes to guidance material on post-implementation monitoring in Appendix D of the Global Operational Datalink Document.

This paper relates to –

Strategic Objectives:
*A: **Safety** – Enhance global civil aviation safety*

Global Plan Initiatives:
GPI-17 Data link applications
GPI-22 Communication infrastructure

1. INTRODUCTION

1.1 The guidance material in GOLD Appendix D "Post Implementation Monitoring" was written in 2009 during the early development of RCP/RSP based post implementation monitoring. The guidance material has been updated and provides additional guidance in a number of areas. These changes reflect the on-going development of RCP/RSP based post-implementation monitoring.

1.2 The revisions also include incorporation of European ATN Baseline 1 CPDLC material.

1.3 The draft Appendix D attached in **Attachment 1** of this paper is the GOLD v1.4.5 review version that was distributed for final review and comment by stakeholders.

2. DISCUSSION

2.1 Paragraph D-1 ANSP Data Collections and Analysis and Paragraph D.1.3 Guidance on frequency of monitoring by ANSP:

> *"ANSP that are currently monitoring data link performance have found that a monthly monitoring interval usually provides enough data points to detect any performance variation and is adequate for post implementation monitoring."*
>
> *"To enable adequate system performance monitoring ANSP should at minimum perform a monthly analysis of CPDLC RCP and ADS-C performance data."*

2.2 Paragraph D.1.1.1.1 CPDLC Controller initiated transactions. Expanded guidance on what message set to use:

> *"Typically all intervention messages with a W/U response attribute, except for non-intervention route messages (UM79, UM80, UM81, UM82, UM83, UM84, UM91, and UM92), contact instructions (UM117-UM123) and UM116 "RESUME NORMAL SPEED" messages are assessed. Data analysis has shown that Pilot Operational Response Time (PORT) to these non-intervention messages can be significantly skewed and will significantly impact measured ACP. However, the removal of all contact instructions (UM117– UM123) will drastically reduce the monthly data set for some smaller ANSP and make it difficult to assess ACTP for individual fleets or aircraft on a monthly basis. For this reason some ANSP retain these (UM117 – Um123) transactions when assessing ACTP. ANSP should decide on a data set that provides them with the best performance modelling for their operation."*

2.3 Paragraph D.1.1.1.1 CPDLC Controller initiated transactions. Guidance provided on filtering zero or negative PORT transactions.

> *"All transactions with zero or negative crew response times should be filtered from data prior to analysis. The time sequence diagram below in Figure D- 2 illustrates the issue. Errors can also arise if there are delays between the ANSP and the CSP on the uplink path. These delays will result in excessive calculated PORT and skewed ACP."*

2.4 Paragraph D1.1.3 Data record for each CPDLC transaction and.D. 3.1 Periodic Reporting. Provides guidance on what should be provided to regional CRA for analysis.

> *"Because different ANSPs may use different data sets for analysis within their area of interest the data sent to a regional state monitoring agency should at minimum contain all transactions that contain a WILCO response. The regional monitoring agency will filter transactions as agreed by their regional forum."*
>
> *"It is recommended that regions implement monthly performance reporting to obtain system performance metrics. These reports will provide data on observed availability, CPDLC transaction time and ADS-C surveillance data transit time as described herein."*

2.5 D.1.3.3.CPDLC Performance Analysis. Section provides guidance on other types of graphs and tabular analysis that can be used. Refer Figure D-5 through D-10 and associated text.

2.6 D.1.3.6 Assessing periodic monitoring results. This is a new section containing guidance on assessing monitoring results. A case study is described in D.1.3.6.4:

> *"The 95% and 99.9% criteria are provided as operationally significant benchmarks against which the surveillance and communication applications supporting ATM functions can be assessed.*
> *Typically post implementation monitoring is carried out on a monthly basis and observed performance assessed to detect any performance degradation.*
>
> *D.1.3.6.1 99.9% Criteria*
>
> *The 99.9% criteria define the Expiry Time (ET) for communication transactions and the Overdue Time (OT) for surveillance transactions following which the initiator is required to revert to an alternative procedure. When using data link*

to provide reduced separations the RCP240 ET and RSP180 OT are the times after which if a CPDLC intervention transaction is not completed or an ADS-C position report is not received then the controller is obliged to revert to alternative separation procedure as defined in the separation specification. If monthly monitoring shows that a specific fleet is not meeting the criteria then a local safety assessment by the ANSP should be carried out to assess if the reduced separation standard can continue to be applied. Some ANSP have set monitoring guidelines as to trigger a safety assessment and further investigation. The safety assessment would consider the density of traffic and traffic patterns flown in the region together with the frequency of application of the reduced separation to assess whether the increased probability of having to revert to an alternative separation would have workload and thus safety implications for the controllers. The safety assessment would also consider the performance of other fleets operating in the airspace.

D.1.3.6.1 95% Criteria

The 95% criteria define the nominal time acceptable for normal CPDLC and ADS-C operations. If monthly monitoring shows that measured performance is consistently below the 95% criteria then consideration may be given to the withdrawal of data link services to the fleet. Experience has shown that observed fleet performance below the specified RCP240/RSP180 95% criteria will usually be accompanied by controller complaints of unacceptable performance by that fleet.

D.1.3.6.2 Setting Guidelines

In airspace where procedural separation is being applied, it has been observed that complete withdrawal of datalink may not be required even if performance is observed to fall below the RCP240/RSP180 criteria. While safety services such as reduced separation standards requiring RCP240/RSP180 would be withdrawn the observed performance may still meet RCP/RSP400 criteria and the local safety assessment may also conclude that maintaining the data link connection is viable.

Some ANSP have set monitoring guidelines to assist with their data analysis. These include:

3. *If the performance observed for a fleet by monthly monitoring at the 99.9% level is better than 99.75% then the fleet is considered to meet the 99.9% performance level.*
4. *Observed fleet performance consistently falling below 99.0% will be subject to CRA problem reports and investigation that will attempt to determine the cause of the degradation.*
5. *Any monthly performance degradation (0.5%) by a fleet below observed historical performance will be subject to investigation.”*

2.8 <u>D.3.1.1 Reporting on availability</u>. Provided guidance on providing a graphical representation of availability in Figure D-21 and D-22.

3. ACTION BY THE MEETING

3.1 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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DRAFT GOLD v1.4.5 Appendix D Post-implementation monitoring and corrective action

The ICAO Global Plan calls for the implementation of a performance based system and ICAO Annex 11 requires that data link system performance is monitored to verify that an acceptable level of safety continues to be met. Annex 11 at paragraph 2.2.7.5 states:

> "Any significant safety-related change to the ATC system, including the implementation of a reduced separation minimum or a new procedure, shall only be effected after a safety assessment has demonstrated that an acceptable level of safety will be met and users have been consulted. When appropriate, the responsible authority shall ensure that adequate provision is made for post-implementation monitoring to verify that the defined level of safety continues to be met."

For continental European airspace, EC Regulation 29/2009 (the DLS IR) stipulates:

> "The quality of service of air-ground data link communications should be regularly monitored by ATS Providers".

It also states:

> "ATS providers shall monitor the quality of service of communication services and verify their conformance with the level of performance required".

The CPDLC system, data link system (ATN or FANS 1/A) and A/G radio links (SATCOM, VDL M2, etc) must operate successfully as a whole to ensure smooth CPDLC operations and to verify that an acceptable level of safety continues to be met. As such a *central* function performing the overall monitoring of normal data link operations, service disruptions and restorations not only at the level of communication service provision but also at CPDLC, data link system and A/G radio link level, will be needed to:

- guarantee performance and inter-operability;
- investigate problems;
- share lessons learned.

Without such a central function this may prove difficult to achieve. This function will need to continue once the Datalink Service is in place to guarantee capacity, performance and inter-operability in the years following successful implementation.

Oversight of the compliance to the Annex 11 requirements is a matter for the States. However, States participate in planning and implementation regional groups (PIRGs), and most use a regional monitoring agency to facilitate monitoring activities within their respective region. The individual states/ANSPs will need to provide the data and information and analysis that will portray regional performance measures. The ANSPs, operators, CSPs, airframe manufacturers, and equipment suppliers all need to participate in reporting and resolving problems associated among the ANSPs and with aircraft.

While individual ANSP will develop the data collection mechanisms, monitoring tools, and internal reporting requirements best suiting their own environment, all ANSP should collect and maintain a database of performance data using the data formats specified in this appendix. These databases will provide the means to aggregate ADS-C surveillance transit time and CPDLC RCP transaction time on a regional and global basis.

Note.— Unlike DO290/ED120 states. The EUR region did not specify an RCP type, but has used TRN as basis for end-to-end performance and allocation determination. Certification and approval, and post-implementation monitoring are based on these parameters.

Monitoring of data communications performance in terms of RCP and RSP is an important part of the performance based system described in the ICAO global plan. To successfully achieve this performance monitoring on a global scale will require the use of a common data set. It is only through this common data set that RCP and RSP data can be aggregated from an ANSP level through to a regional monitoring agency level and then to global level. This aggregation of performance data is in accordance with the guidelines provided in ICAO Doc 9883 Manual on Global Performance of the Air Navigation System.

In addition to monitoring data communications performance future development of data link communications applications would be assisted if existing message use statistics were available. ANSP should maintain message use statistics.

This appendix contains the following guidance material:

a. ANSP data collection and analysis - This section defines a common data reporting format. Guidance material is included on how to obtain the required data points from the FANS 1/A ACARS and ATN B1 messages and on the calculation of actual communication performance (ACP), actual communication technical performance (ACTP), pilot operational response time (PORT), actual surveillance performance (ASP), and how they are calculated. Examples of the type of analysis that can be carried out at an ANSP level are also included. Issues regarding data filtering are discussed including guidance on how to manage this.

b. Problem reporting and resolution – This section provides guidance on the problem identification and resolution process

c. Regional performance monitoring – This section provides guidance on the monitoring of ADS-C actual surveillance performance and CPDLC actual communication performance at a regional level.

D.1 ANSP data collection and analysis

Data link performance requirements for the application of reduced separation standards, as defined in ICAO Doc 4444, are contained in the following documents:

a. RTCA DO-306/EUROCAE ED 122 – Oceanic SPR standard. These requirements are specified in terms of RCP and RSP.

b. RTCA DO 290/EUROCAE ED 120 – Continental SPR standard. The EUR instantiation of DO290/ED120 comprises the performance requirements for DLIC (Logon and Contact) and CPDLC (ACM, ACL).

ANSP that are currently monitoring data link performance have found that a monthly monitoring interval usually provides enough data points to detect any performance variation and is adequate for post implementation monitoring.

D.1.1 ANSP data collection for CPDLC application

This section provides guidance on data collection and performance measurement for the CPDLC application.
For Procedural airspace, the measurements are taken from CPDLC ground-initiated transactions.
For EUR Continental airspace, the following measurements are taken:

a. DLIC-contact transactions;

b. CPDLC ground-initiated and air-initiated transactions.

Note.— Air-initiated and ground initiated transactions will be analysed separately since they have different performance requirements (refer to ***Error! Reference source not found.****).*

D.1.1.1 Measuring CPDLC communication performance

CPDLC analysis is based on the calculation of actual communication performance (ACP) used to monitor RCP time allocation for communication transaction (TRN), actual communications technical performance (ACTP) used to monitor required communication technical performance (RCTP) time allocation, and pilot operational response time (PORT) used to monitor the responder performance criteria of the transaction.

Note.— For EUR Region, ANSPs that accommodate FANS 1/A aircraft, monitor the performance of ATN aircraft separately from FANS1/A aircraft. As the underlying technology is different.

D.1.1.1.1 CPDLC controller-initiated transactions

The analysis uses the measurement of transit and response times to a subset of CPDLC uplinks that receive a single DM 0 WILCO response. Responses not measured are where an uplink receives DM 1 UNABLE, DM 2 STANDBY, DM 3 ROGER, DM 4 AFFIRM, DM 5 NEGATIVE responses. A DM 0 WILCO response following a DM 2 STANDBY is also not measured. The rationale behind this is that the critical communications requirement is provided by intervention messages when applying reduced separation standards. Incorporating other message types such as free text queries, information requests not requiring a DM 0 WILCO response, messages with DM 1 UNABLE responses, or DM 2 STANDBY responses followed by DM 0 WILCO, or non-intervention re-route messages UM79, UM80, and UM83 will skew the observed data because of the longer response times from the flight deck.

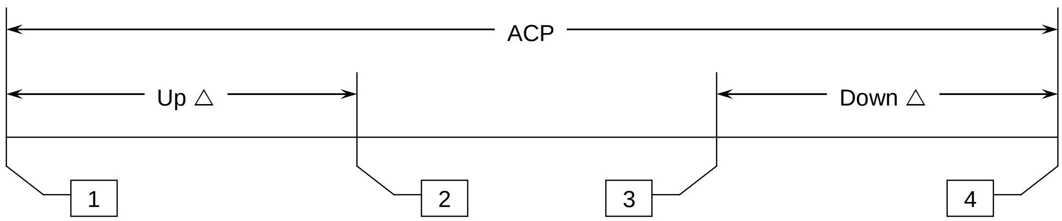
Typically all intervention messages with a W/U response attribute, except for non-intervention route messages (UM 79, UM 80, UM 81, UM 82, UM83, UM84, UM91, and UM92), contact instructions (UM 117 – UM 123) and UM 116 “RESUME NORMAL SPEED” messages are assessed. Data analysis has shown that Pilot Operational Response Time (PORT) to these non-intervention messages can be significantly skewed and will significantly impact measured ACP. However, the removal of all contact instructions (UM 117-UM 123) will drastically reduce the monthly data set for some smaller ANSP and make it difficult to assess ACTP for individual fleets or aircraft on a monthly basis. For this reason some ANSP retain these (UM 117-UM 123) transactions when assessing ACTP. ANSP should decide on a data set that provides them with the best performance modeling for their operation.

Note.— UM79 and UM 80 are assessed in EUR airspace.

To calculate ACP, the difference between the times that the uplink message is originated at the ANSP to the time that the corresponding response downlink is received at the ANSP is used.

To calculate ACTP, the difference between the downlink's aircraft time stamp and the received time is added to half the round trip time determined by the difference between the uplink time when the message is sent from the ANSP and the receipt of the MAS (FANS 1/A) or LACK (ATN B1) response for the uplink at the ANSP ((uplink transmission time – MAS/LACK receipt)/2 + downlink time).

PORT is calculated by the difference between ACP and ACTP. Figure D- 1 illustrates these measurements.



1. Uplink Sent. This is the date/time that the CPDLC clearance was sent to the aircraft.
2. MAS/LACK Received. This is the date/time that the MAS/LACK for the CPDLC clearance was received.
3. WILCO Sent. This is the date/time that the WILCO reply is transmitted.
4. WILCO Received. This is the date/time that the WILCO reply for the CPDLC clearance was received.

The measurements (in seconds) are calculated as follows:

$$\mathrm{ACP} = (\mathrm{WILCO\_Received}) - (\mathrm{Uplink\_Sent}) \rightarrow \textbf{TRN}$$

$$\mathrm{ACTP} \cong \left(\left(\frac{\mathrm{Up}\Delta}{2} \right) + (\mathrm{Down}\Delta) \right) \rightarrow \textbf{RCTP}$$

$$\mathrm{PORT} \cong \mathrm{ACP} - \mathrm{ACTP} \rightarrow \textbf{Responder}$$

Figure D- 1. CPDLC transaction calculations

The values for ACTP and PORT are only approximations. Uplink transit times are estimated by taking half the time for the MAS/LACK response round trip. This assumption is flawed in a small percentage of cases because we know it is possible for the MAS to be received at the ANSP after the operational response is received; or for the timestamp on the operational response to be earlier than the MAS receipt time. This will happen if the CSP does not hear the network ACK from the aircraft (which is sent on uplink receipt) and resends the uplink later. The CSP receives the network ACK to this second uplink and sends the MAS to the ANSP. In the meantime, the aircraft has already responded with the operational response. ANSP will see this issue reflected in their data with crew response times with negative or extremely small values. All transactions with zero or negative crew response times should be filtered from data prior to analysis. The time sequence diagram below in Figure D- 2 illustrates the issue. Errors can also arise if there are delays between the ANSP and the CSP on the uplink path. These delays will result in excessive calculated PORT and skewed ACP.

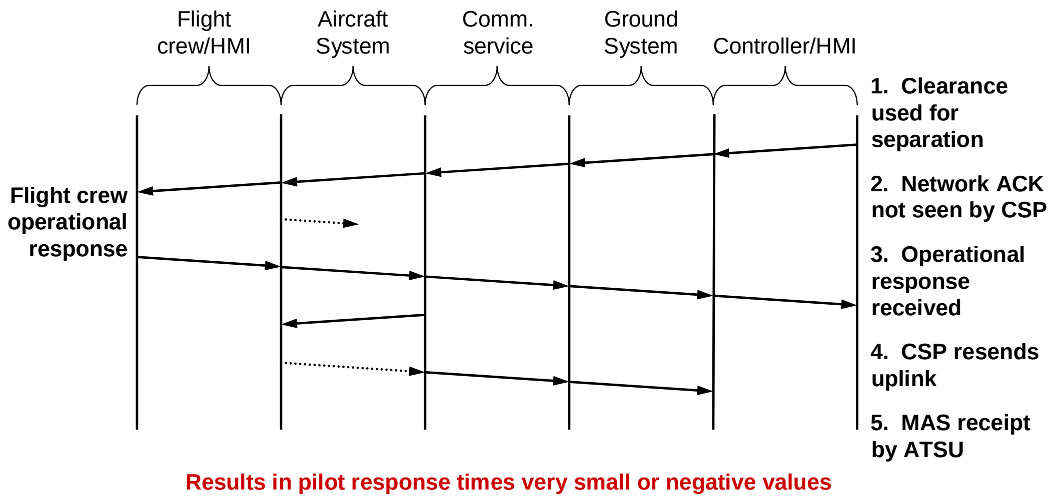


Figure D- 2 Issue with estimating uplink transit time as half MAS roundtrip

D.1.1.1.2 CPDLC Flight crew-initiated transactions

The EUR region measures the transit and response times to a subset of CPDLC downlinks that receive a single UNABLE or Clearance response.
To calculate ACP, the difference between the time in the header of the LACK message acknowledging the response to the time in the CPDLC header of the downlinked request message. Figure D- 3 illustrates the measurements.

Note.— The time provided in the header of the LACK message, sent from the aircraft, can be considered as giving a fairly accurate indication of when the associated uplink response has been processed and is available to the flight crew.

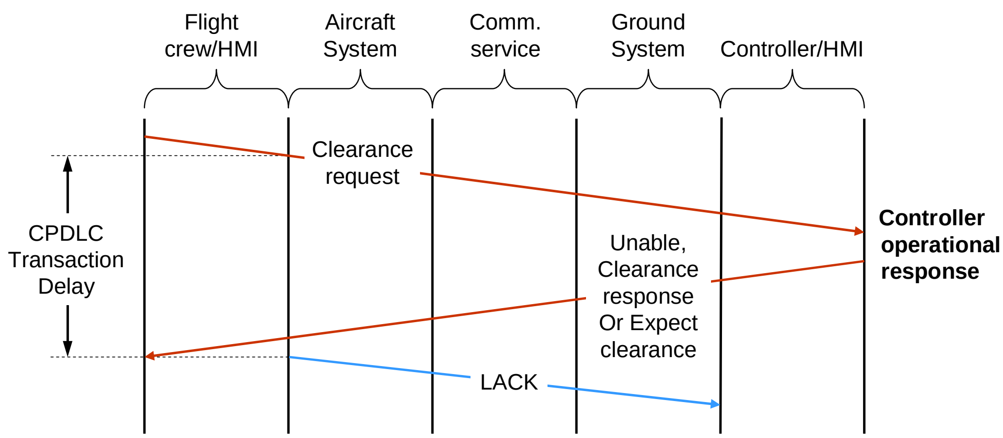


Figure D- 3 Flight crew-initiated ACP delay

D.1.1.1.3 DLIC-Contact transactions

The EUR region measures the DLIC-Contact transaction delay. The ACP is calculated by the difference between the Contact response reception time and the Contact request transmission time as is illustrated in Figure D-4.

Note.— It is not possible to accurately measure DLIC-Logon transactions. Moreover, a logon is normally initiated well in advance of establishing a CPDLC connection with the first ATSU.

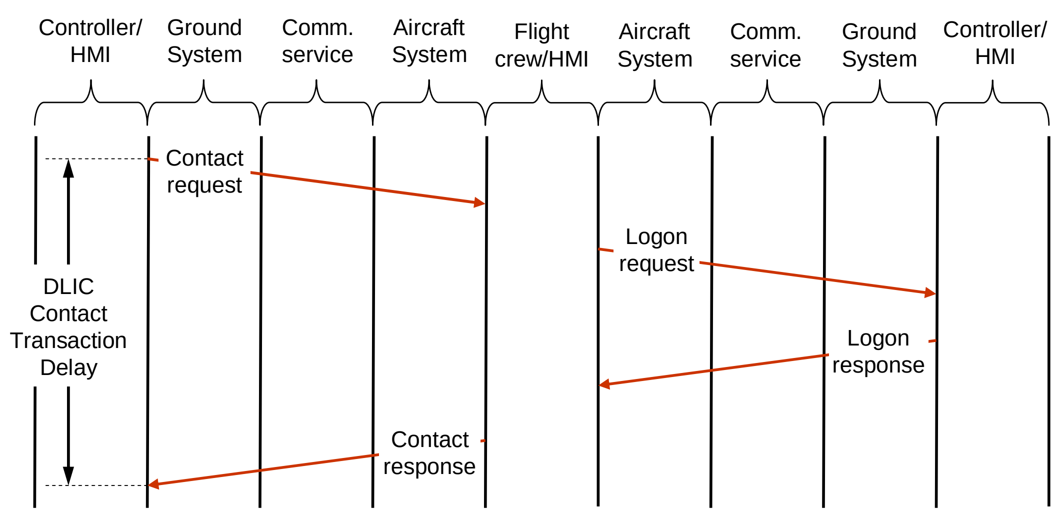


Figure D- 4 DLIC Contact transaction

D.1.1.2 Recording the data points for each CPDLC transaction

The following data points in Table D-1 are recommended as the minimum set that should be extracted from ANSP data link 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 requirements and some possibilities are listed below. To obtain these data points ANSP should note that they will require additional database information to enable the aircraft type and operator to be obtained by correlation to the aircraft registration extracted from the data link recordings. All of the other data points are extracted from either the ACARS or ATN B1 header or the CPDLC application message.

Table D-1 CPDLC data collection points

Ref	Label	Description and/or remarks
1	ANSP	The four letter ICAO designator of the facility (e.g. NZZO).
2	Aircraft registration (FANS 1/A)	The aircraft registration in ICAO Doc 4444 Format (no hyphens, packing dots, etc.) (e.g. N104UA). *Note.— Extracted from ACARS header or application message.*
2	Aircraft address (ATNB1)	The 24 bit address in ICAO Doc4444 Format (alphanumerical character, in six hexadecimals) *Note.— Extracted from CM application message.*
3	Aircraft type designator	The ICAO aircraft type designator (e.g. B744). *Note.— Extracted from ANSP database using aircraft registration as key.*
4	Operator designator	The ICAO designator for the aircraft operating agency (e.g. UAL). *Note.— Extracted from ANSP database using aircraft registration as key.*
5	Date	In YYYYMMDD format (e.g. 20081114). *Note.— Extracted from ANSP system data recording time stamp, synchronized to within 1 second of Universal Time Coordinated (UTC).*
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, synchronized to within 1 second of UTC.*
9	MAS/LACK receipt time	The ANSP timestamp on receipt of the MAS in HH:MM:SS format (e.g. 03:43:35). *Note.— Extracted from ANSP system data recording time stamp, synchronized to within 1 second of UTC.*

Ref	Label	Description and/or remarks
10	MAS/LACK round trip time	In seconds (#9-#8) (e.g. 10).
11	Aircraft FMS time stamp	In the operational response messages in HH:MM:SS (e.g. 03:44:15). *Note 1.— For FANS 1/A, extracted from the ATCmessageHeader timestamp in the decoded operational response message. See RTCA DO-258AEUROCAE ED-100A section 4.6.3.3.* *Note 2. — For ATN B1, extracted from the Aircraft CPDLC, timestamp in the decoded operational response message.*
12	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, synchronized to within 1 second of UTC.*
13	Operational message round trip time	From sending uplink (#8) to receipt of operational response (#12) 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 identifier 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	Pilot Operational Response Time = ACP (#18) - ACTP(#17) (e.g. 45). *Note.— Implementers should allow for negative values where the operational response is received before the MAS as per Figure D- 2 above. When graphing PORT negative values should be counted as 0.*

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

a. The aircraft call sign extracted from either the Flight Plan (e.g. ANZ123) or the logon request message for the flight (e.g. NZ123) or the FI line in the ACARS header (e.g. NZ0123);

b. Direction of flight calculated by the flight data processor and displayed as a three figure group representing degrees true (e.g. 275); and

c. The estimated position in latitude and longitude of the aircraft when a CPDLC downlink is sent. Calculated by the flight data processor. For consistency the following formats are recommended: For latitude use “+” for North or “-” for South followed by a decimal number of degrees (e.g. -33.456732).

For longitude use "+" for East or "-" for West followed by a decimal number of degrees (e.g. +173.276554).

d. The datalink communications type (COMTYP). Extracted from the MAS RGS and OPS RGS identifying the media used for the uplink and downlink message. There are nine possible entries for COMTYP: SAT, VHF, HF, SV, SH, VS, VH, HS, HV. Value is based on the MAS RGS field (#6) and OPS RGS (#7) and are listed in Table D-2.

e. The regional CRA should consider promulgating a list of RGS designators that are applicable to their region.

Table D-2. Determination of COMTYP indicators

MAS RGS Communication Type	OPS RGS Communication Type	COMTYP
SAT (e.g. MAS RGS = POR1)	SAT (e.g. OPS RGS = POR1)	SAT
VHF (e.g. MAS RGS = ADK)	VHF (e.g. OPS RGS = ADK)	VHF
HF (e.g. MAS RGS = H02)	HF (e.g. OPS RGS = H02)	HF
SAT (e.g. MAS RGS = POR1)	VHF (e.g. OPS RGS = ADK)	SV
SAT (e.g. MAS RGS = POR1)	HF (e.g. OPS RGS = H02)	SH
VHF (e.g. MAS RGS = ADK)	SAT (e.g. OPS RGS = POR1)	VS
VHF (e.g. MAS RGS = ADK)	HF (e.g. OPS RGS = H02)	VH
HF (e.g. MAS RGS = H02)	VHF (e.g. OPS RGS = ADK)	HV
HF (e.g. MAS RGS = H02)	SAT (e.g. OPS RGS = POR1)	HS

For ATN B1 and FANS 1/A service provision in EUR Region, the following additional data should be provided:

a. ***DLIC Initiation Logon Counts***. The number of unsuccessful logon attempts, the number of successful logon attempts followed by the establishment of a CPDLC connection, and the number of successful logon attempts that are not followed by the establishment of a CPDLC connection.

b. ***Continuity for DLIC-Contact and CPDLC ground-initiated and air-initiated transactions***. As the performance requirements are different for ground-initiated transactions and air-initiated transactions, the actual probability for Continuity is calculated separately for ground-initiated and air-initiated transactions

c. ***Availability (Use)***. The number of Provider Aborts experienced by the ANSP and manually reported availability problems affecting a single aircraft.

Note.— Measuring actual probability of A(USE) according to formal definition is problematic. An acceptable indication is by counting the number of provider aborts (The Air-Ground connectivity is lost after 6 minutes)

d. ***Availability(Provision)***. Defined as Actual hours of CPDLC Operations / Planned Hours of CPDLC Operations, where:

1) ***Actual hours*** of CPDLC Operations = Planned Hours of CPDLC Operations - Accumulated declared unplanned service outages.

2) ***Planned Hours of CPDLC Operations*** = 24x7 operations over a certain period – planned service outages

3) ***Accumulated declared unplanned service outages*** = sum of all partial failures (affecting multiple aircraft) or total failure (affecting all aircraft) over a certain period.

4) ***Unplanned service outages*** affecting more than one aircraft are due to problems, originated from e.g. FDP, ACSP, VDL GS, router

e. ***Deployment indicators*** using:

1) ***Fleet Equipage***. The percentage of the aircraft fleet equipped to use CPDLC.

2) ***Fleet Usage***. The percentage of the aircraft fleet equipped to use CPDLC that are actually using CPDLC operationally.

f. ***System health indicators***, using:

1) ***User Aborts***. The number of user aborts.

2) ***Error messages***. The number of different types of error message.

3) ***Message Usage***. The number of different ACL and ACM messages sent.

4) ***Transport level (TP4) retries (ATN B1)***. The number of uplink retries per ground end-system identifying which aircraft were involved, along with the ratio of the number of uplink TP4 retransmissions to the number of successfully transmitted Data TPDUs per ground end- system. Monitoring the rate of TP4 retries for each system on the ground and identifying which aircraft are involved will allow the identification of problems occurring within the network/ground system or with a particular aircraft.

Note.— A TP4 retry could occur as the result of i) temporary delays , ii) unavailability of a component of the network, iii) a dysfunctional VDL handoff or iv) a problem in an end- system (ATSU or avionics).

5) ***Failed transport connection attempts (ATN B1)***. The number of failed transport connection attempts measured per ground end-system identifying which aircraft were involved. Monitoring the number of failed attempts to establish a transport level connection will give an indication of problems with the slightly longer term availability of one of the end-systems or the underlying network.

6) ***TP4 Round Trip Delay (ATN B1)***. The time taken from the transmission of a Data TPDU to its acknowledgement.

g. ***Inconsistency in flight plan and log on association***. The number of inconsistencies found in flight plan - logon association criteria (i.e Flight Id/ICAO Code,datalink equipment&capability in item 10a).

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

h. ***Air-ground VDLM2 data***. CSP sends VDLM2 data to the CRO, which may be supplemented with VDLM2 data from ANSPs for VDLM2 frequency capacity planning and problem investigation.

D.1.1.3 Data record for each CPDLC transaction

If required for regional monitoring agency analysis CPDLC transaction data as described above may be sent to the regional/State monitoring agency at as a comma delimited text file. The format for each record will at minimum contain the 20 data points specified in table D-1. Using the example in the previous paragraph the data record for the transaction described above in comma delimited format is:

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

Guidance on the type of analysis carried out at an ANSP or regional level is provided later in paragraphs 0 and 0.

Because different ANSPs may use different data sets for analysis within their area of interest the data sent to a regional state monitoring agency should at minimum contain all transactions that contain a WILCO response. The regional monitoring agency will filter transactions as agreed by their regional forum.

D.1.2 ANSP data collection for ADS-C application

This section provides guidance on data collection and performance measurement for the ADS-C application.

D.1.2.1 Measuring actual surveillance performance (ASP)

The analysis of actual communication performance (ASP) is based on the measurement of the transit times of the ADS-C periodic and event reports between the aircraft and the ANSP ground system. This is measured as the difference between the time extracted from the decoded ADS-C basic group timestamp when the message originated from the FMS and the time the message is received at the ANSP.

D.1.2.2 Recording the ADS-C data points for each ADS-C downlink.

The following data points in Table D-3 are recommended as the minimum set that should be extracted from ANSP data link system recordings to enable an analysis of ADS-C performance and provide sufficient information for problem analysis. This does not preclude individual ANSP from extracting additional data points for their own analysis and some possibilities are listed below. 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 aircraft registration extracted from the data link recordings. All of the other data points are extracted from either the ACARS header or the ADS-C application message.

Table D-3 ADS-C data collection points

Ref	Label	Description and/or remarks
1	ANSP	The four letter ICAO designator for the facility (e.g. NZZO).
2	Aircraft Registration	The aircraft registration in ICAO Doc 4444 Format (no hyphens, packing dots, etc.) (e.g. N104UA). *Note.— Extracted from ACARS header or application message.*
3	Aircraft Type Designator	The ICAO aircraft type designator (e.g. B744). *Note.— Extracted from ANSP database using aircraft registration as key.*

Ref	Label	Description and/or remarks
4	Operator Designator	The IATA designator for the aircraft operating agency (e.g. UAL). *Note.— Extracted from ANSP database using aircraft registration as key.*
5	Date	In YYYYMMDD format (e.g. 20081114). *Note.— Extracted from ANSP system data recording time stamp, synchronized to within 1 second of UTC.*
6	RGS	Designator of the RGS that ADS-C 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-C report extracted from the ADS-C basic group report tag where tag value 7=PER, 9=EMG, 10=LDE, 18=VRE, 19=ARE, 20=WCE. As some aircraft concatenate more than one report in the same downlink extract the ADS-C report tag from each ADS-C basic group and identify them in the REP_TYPE column by using the first letter of the report type as an identifier (e.g. for a concatenated report containing two ADS-C basic groups for a periodic report and a waypoint event report the field will contain PW). Where a downlink does not contain a ADS-C basic group the REP_TYPE field will be left blank.
8	Latitude	The current latitude decoded from the ADS-C basic 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 ADS-C basic 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-C message was sent from the aircraft in HH:MM:SS (e.g. 03:44:15). *Note.— Decoded from the ADS-C basic group timestamp extracted as seconds since the most recent hour. See RTCA DO-258A/EUROCAE ED-100A, section 4.5.1.4.*
11	Received Time	The ANSP timestamp on the receipt of the ADS-C message in HH:MM:SS (e.g. 03:44:45). *Note.— Extracted from ANSP system data recording time stamp, synchronized to within 1 second of UTC.*
12	Transit Time	The transit time of the ADS-C downlink in seconds calculated as the difference between #10 Aircraft Time and #11 Received Time (e.g. 30).

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

a. The aircraft call sign extracted from either the Flight Plan (e.g. ANZ123), the AFN logon for the flight (e.g. NZ123) or the FI line in the ACARS header (e.g. NZ0123).

b. Direction of flight calculated by the ANSP flight data processor and displayed as a three figure group representing degrees true (e.g. 275).

c. The current altitude (e.g. 35000) decoded from the ADS-C basic group. The altitude combined with the latitude, longitude, and time provide the aircraft position at the time the report was generated.

Aircraft movement data is needed in airspace safety assessments and/or airspace safety monitoring analyses. Inclusion of altitude in the GOLD data sample would allows for the GOLD data to be used for both data link performance monitoring and airspace safety monitoring analyses,

d. ADS-C predicted position latitude and longitude and time when available. (Note: time decoded from the ADS-C predicted group where timestamp is extracted as seconds since the most recent hour. (See RTCA DO-258A section 4.5.1.4)) For consistency the following formats are recommended: For latitude use "+" for North or "-" for South followed by a decimal number of degrees (e.g. -33.456732). For longitude use "+" for East or "-" for West followed by a decimal number of degrees (e.g. +173.276554).

e. The data link communications type (COMTYP) based on the RGS field (#6). Satellite (SAT), Very High Frequency (VHF), High Frequency (HF). Refer to Table D-2.

D.1.2.3 Data record for each ADS-C downlink

If required for regional/State monitoring agency analysis ADS-C transaction data as described above may be sent to the regional regional/State monitoring agency as a comma delimited text file. The format for each record will at minimum contain the 12 data points specified in table D-2. Using the example in the previous paragraph the data record for the transaction described above in comma delimited format is:

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

Guidance on the type of analysis carried out at an ANSP or regional level is provided later in paragraphs D.1.3 and D.2.1.

D.1.3 ANSP data analysis

To enable adequate system performance monitoring ANSP should at minimum perform a monthly analysis of CPDLC RCP and ADS-C performance data. This monitoring will verify system performance and also enable continuous performance improvement by detecting where specific aircraft or fleets are not meeting the performance standards.
While this analysis could be carried out by a regional monitoring agency, it is thought the analysis will be more efficient if done by the ANSP. It is the ANSP that will usually have the operational expertise and local area knowledge that is important when identifying problems from any data analysis. At least one region has had considerable success by using some of the regional ANSP to complete a monthly data analysis and reporting the identified problems to the regional monitoring agency for resolution.

A regional monitoring agency is best suited to manage problems reported from the ANSP analysis, and to develop actual regional performance figures from information supplied by the ANSP. Analysis by the individual ANSP will also avoid the regional monitoring agency having to manage a large quantum of data that the ANSP already holds.

D1.3.1 Graphical analysis

It is recommended that ANSP perform a graphical analysis of the performance data gathered. This graphical analysis is useful for depicting in a readily assimilated fashion actual performance, and has proved extremely useful when identifying performance problems. Monitoring can be completed at a number of levels and similar levels can be used for both CPDLC and ADS-C performance monitoring. The following structure is recommended:

a. Monitoring Communication Media Performance. An analysis of:

1) Data from all aircraft via all Remote Ground Station (RGS) types.

2) Data from all aircraft via SATCOM RGS

3) Data from all aircraft via VHF RGS

4) Data from all aircraft via HF RGS

5) Data from all aircraft via HF and SATCOM RGS

Note.— The monitoring of combined HF and SATCOM data is to allow verification that the performance obtained from those aircraft using HFDL for downlinks only when SATCOM is not available does not degrade performance by an unacceptable level.

b. Monitoring Airline Fleet Performance. An analysis of:

1) The observed performance of each type of aircraft operated by an operator:

i) Via SATCOM

ii) Via SATCOM + HF

iii) Via HF

iv) Via VHF

v) Via All RGS

2) Comparative analysis of the observed performance from the same type of aircraft from different operators.

Note.— When measuring CPDLC performance for a specific media type(s) then only those transactions where both the RGS for the MAS and the RGS of the operational response are from that media type would be measured. Mixed media transactions such as where the MAS is received via a VHF RGS and the operational response is via a SATCOM RGS would be excluded from a SATCOM analysis. Mixed media transactions would be counted in the SATCOM + HF, and All RGS analysis above.

D.1.3.2 Data filtering

It is important that consistent data filtering is employed to ensure that all ANSP measure against the same baseline. Raw data obtained from the ANSP recordings will include delayed transactions measured during periods of system outage and these should not be used when assessing CPDLC transaction time or surveillance data transit time. The data may also include duplicated messages which will also skew the measurements if not removed. This data should be filtered from the raw data before any performance assessment is made.

D.1.3.2.1 System Outages

In accordance with the provisions of paragraph 3.1.3**Error! Reference source not found.**, the ANSP should ensure that the service level agreement with their CSP includes a requirement for the reporting of all system outages that will affect the delivery of traffic to and from the ANSP. CSP reporting should include for each outage:

a. Type of outage and the media affected;

b. Outage start time;

c. Outage end time; and

d. Duration of Outage.

The raw data should be checked for any delayed transactions observed during system outages. These delays are easily identified during outages that have been notified by the CSP, but the data should be carefully reviewed for outages that have not been notified. Delays observed from multiple aircraft where the downlinks completing the transactions are received at similar times indicate a system outage. CPDLC transactions and surveillance data delivery measurements during these outage periods should be removed. A typical outage not notified by any DSP is illustrated in Table D- 4 showing ADS-C downlink delays from 3 aircraft between 1120 and 1213.

Table D- 4. ADS-C outages not notified

Aircraft registration	Aircraft time	ANSP system time	Downlink time (Seconds)
ZK-SUI	11:55:38	12:12:52	1034
ZK-SUI	11:44:42	12:12:19	1657
ZK-SUJ	11:41:54	12:12:01	1807
ZK-SUJ	11:26:18	12:09:42	2604
ZK-SUI	11:23:21	12:08:32	2711
ZK-SUJ	11:20:34	12:07:39	2825
ZK-OKG	11:53:52	12:12:51	1139

D.1.3.2.2 Duplicated ADS-C reports

Numerous instances of duplicate ADS-C reports are observed in FANS-1/A data records. A particular report is often duplicated with the second and sometimes third record duplicated at some later time as illustrated in Table D- 5. These duplicate records will skew ADS-C surveillance data delivery measurements and should be removed.

Table D- 5. ADS-C duplicate reports

LAT_LON	Aircraft time	ANSP system time	Downlink time (Seconds)
350225S1694139E	22:29:45	22:31:04	79
350225S1694139E	22:29:45	22:34:56	311
350225S1694139E	22:29:45	22:40:05	620

D.1.3.3 CPDLC performance analysis

Monitoring of CPDLC performance involves an assessment of ACP, ACTP, and PORT by a graphical analysis of data using the structure outline in paragraph D.1.3.1.

D.1.3.3.1 Monitoring communications media performance

Graphs illustrating ACP and ACTP are used to assess CPDLC transaction performance through the various communications media. Since PORT is independent of media this would normally only be assessed over one media. The graphs depict measured performance against the TRN and RCTP requirements at the 95% and 99.9% level and would be completed for the performance specifications in use (e.g. RCP 240, RCP 400). An analysis is completed for:

a. Data from all aircraft via all remote ground station (RGS) types.

b. Data from all aircraft via SATCOM RGS

c. Data from all aircraft via VHF RGS

d. Data from all aircraft via HF RGS

e. Data from all aircraft via HF and SATCOM RGS

A typical graph illustrating SATCOM ACTP performance constructed using a spreadsheet application is illustrated in Figure D- 5. Similar graphs are used to assess ACTP and ACP for other communications media.

Figure D- 5 graphs ACTP against the 95% 120” and 99.9% 150” requirements of the RCP240 specification for the years 2009-2012 as observed in the NZZO FIR.

Figure D- 6 and Figure D- 7 illustrate other methods of reporting performance.

Data transactions used for the measurement of SATCOM, VHF, and HF ACTP and ACP are where both the MAS and operational response are received via the media being assessed. The exception to this is the assessment of combined HF and SATCOM performance where any transaction involving HF or SATCOM is used.

Similar graphs are used to assess ACTP and ACP for other communications media.

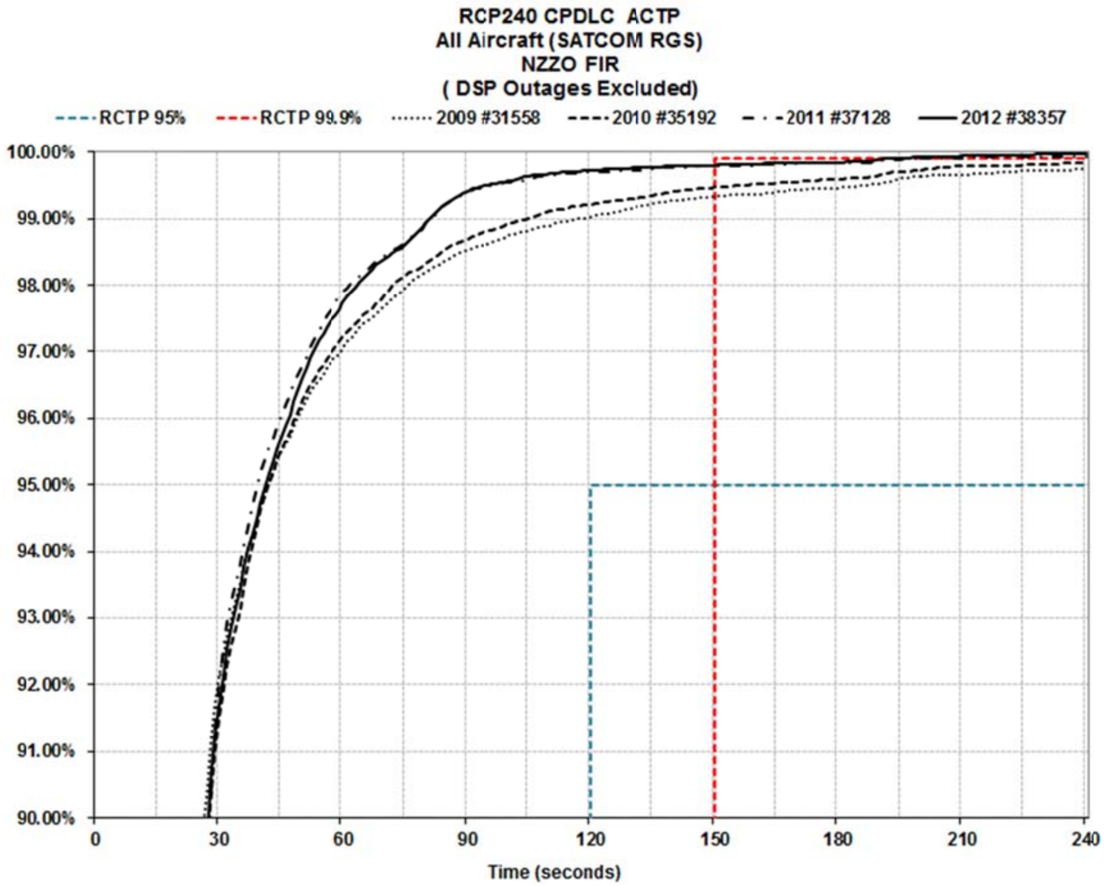


Figure D- 5. CPDLC ACTP performance - Example 1 Graphical by year

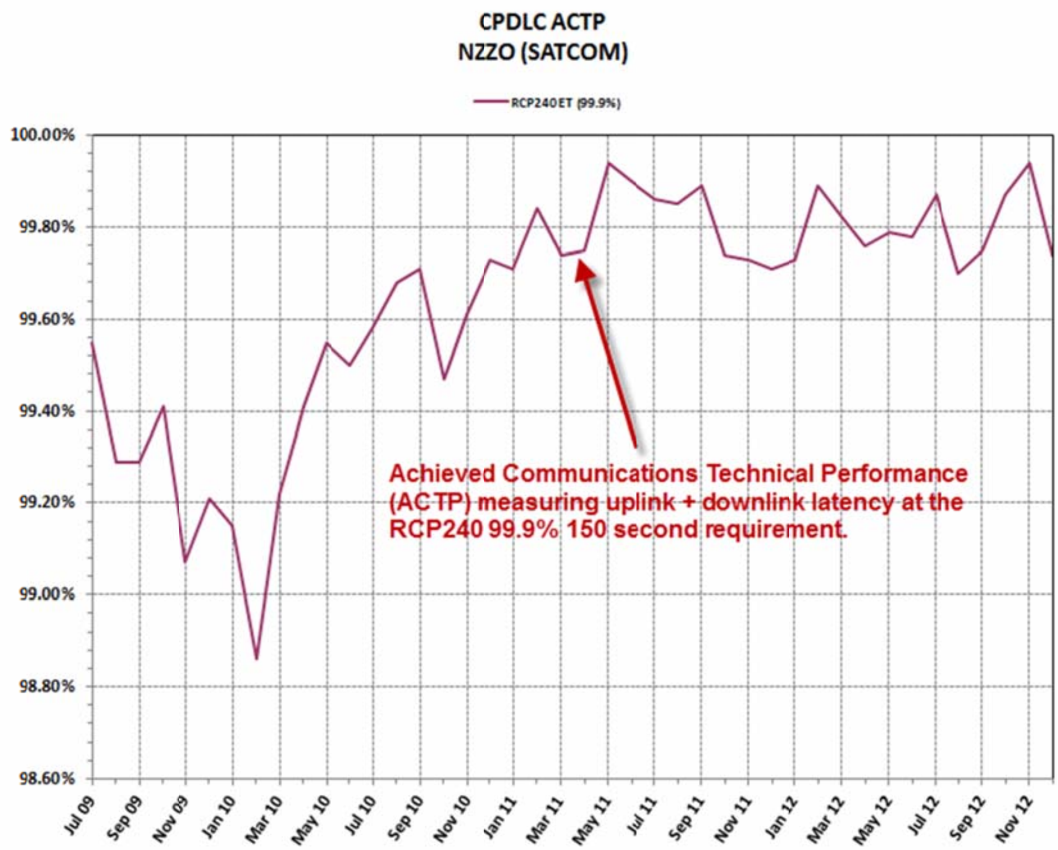


Figure D- 6 CPDLC ACTP performance – Example 2 Graphical Analysis by Month

Operator	Type	# Messages	% of Total	RCTP 95% 120sec	RCTP 99.9% 150 sec
DDD	B772	457	13.08%	100.00%	100.00%
OOO	B77W	414	11.85%	100.00%	100.00%
XXX	B744	392	11.22%	100.00%	100.00%
GGG	B744	218	6.24%	100.00%	100.00%
VVV	B772	118	3.38%	100.00%	100.00%
SSS	A388	104	2.98%	100.00%	100.00%
AAA	A343	85	2.43%	100.00%	100.00%
YYY	B77W	76	2.18%	100.00%	100.00%
UUU	A388	67	1.92%	100.00%	100.00%
RRR	B772	63	1.80%	100.00%	100.00%
MIL	VARIOUS	60	1.72%	100.00%	100.00%
FFF	B772	59	1.69%	100.00%	100.00%
A2F	A332	50	1.43%	100.00%	100.00%
KKK	B744	43	1.23%	100.00%	100.00%
JJJ	A332	37	1.06%	100.00%	100.00%
A2E	A333	36	1.03%	100.00%	100.00%
TTT	A333	34	0.97%	100.00%	100.00%
HHH	B744	31	0.89%	100.00%	100.00%
A2C	B744	92	2.63%	98.91%	100.00%
OTHER	VARIOUS	31	0.89%	93.55%	100.00%
MMM	A332	258	7.38%	98.84%	99.61%
ZZZ	A343	219	6.27%	99.54%	99.54%
QQQ	B77W	155	4.44%	99.35%	99.35%
PPP	B77W	220	6.30%	98.18%	98.64%
NNN	B744	114	3.26%	97.37%	97.37%
A2D	A332	61	1.75%	91.80%	93.44%

Figure D- 7 CPDLC ACTP performance – Example 3 Tabular Analysis for a Month

D.1.3.3.2 Monitoring Airline Fleet Performance

Graphs illustrating ACP, ACTP, and PORT can be used to monitor the performance of each aircraft type in an operator's fleet. These should be maintained on a monthly basis and can be used to observe the performance of each type when using different media such as: via SATCOM; via SATCOM + HF; via HF; via VHF; and via all RGS. A SATCOM ACP analysis between 2009-2012 for a B744 fleet operating in the NZZO FIR is illustrated in Figure D- 9.

Figure D- 9 graphs CPDLC ACP against the 95% 180" and 99.9% 210" requirements for RCP240 annual aggregates for the years 2009-2012. Performance variations may be observed from month to month and these variations can be monitored over a number of months to detect any significant performance degradation that should be investigated further. Typical monthly variations are depicted in Figure D- 9. Performance variations in any month may be the result of poor performance from an individual aircraft or may simply be the result of routes changing month to month with varying weather patterns. Any significant degradation may be investigated further using an analysis of individual tails in a fleet as discussed in paragraph 0.

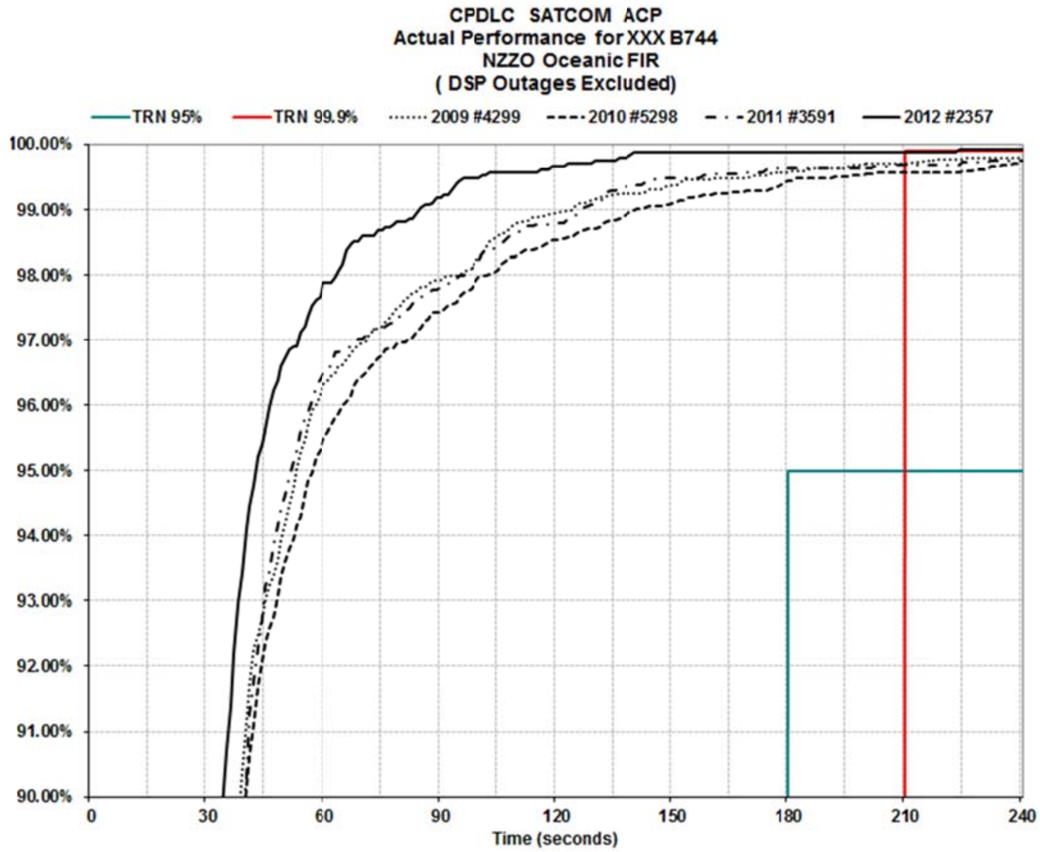


Figure D- 8 CPDLC ACP Airline XXX B744 2009-2012

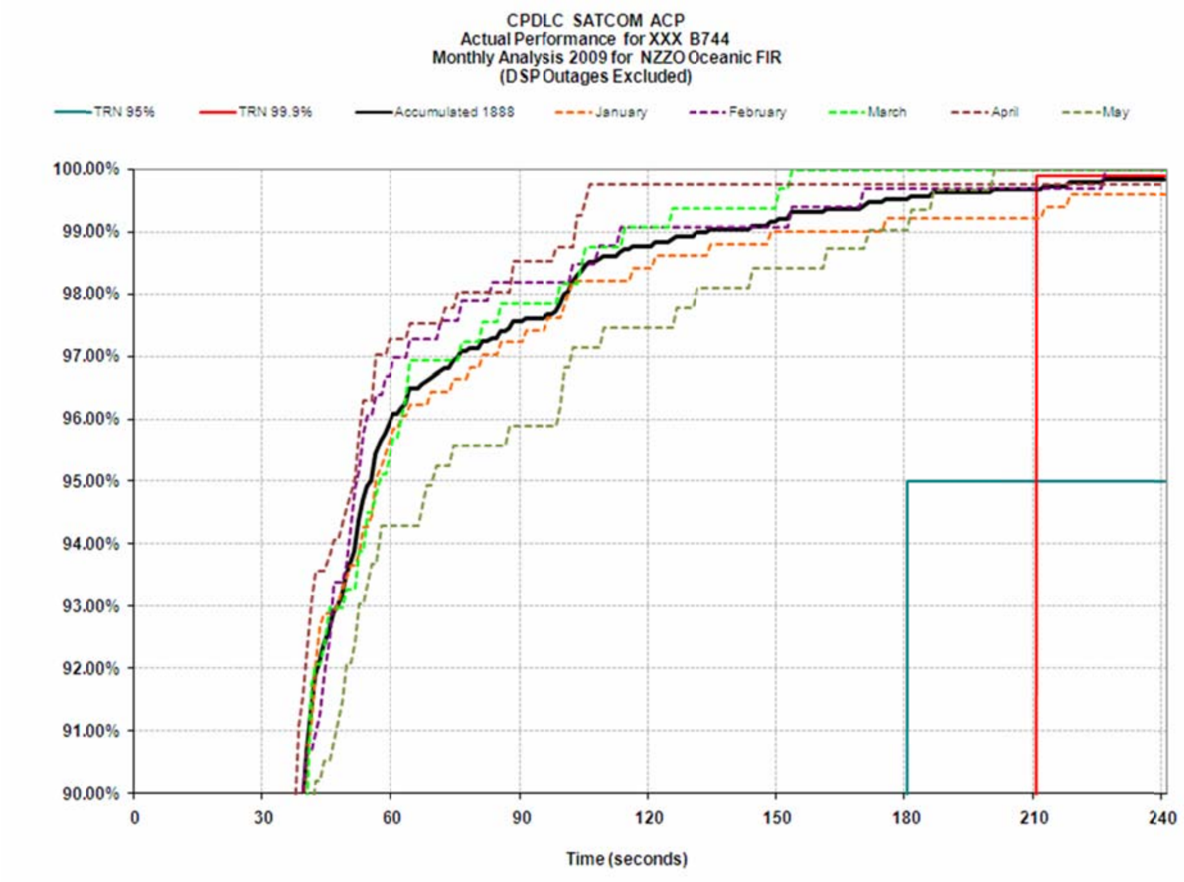


Figure D- 9. Typical Monthly variation in CPDLC ACP

A comparative analysis of the performance of different fleets operating in an ATSU's airspace particularly of fleets of the same type is useful. Under performing fleets can be identified for further analysis and a picture of typical performance from all fleets can be built up. These can be compared with the same fleets operating in other ATSUs' airspace.

Figure D- 10 graphs SATCOM ACTP for a number of fleets operating in NZZO FIR during 2012. Significant variations in observed performance should be flagged for further analysis as discussed in paragraph D.1.3.5.

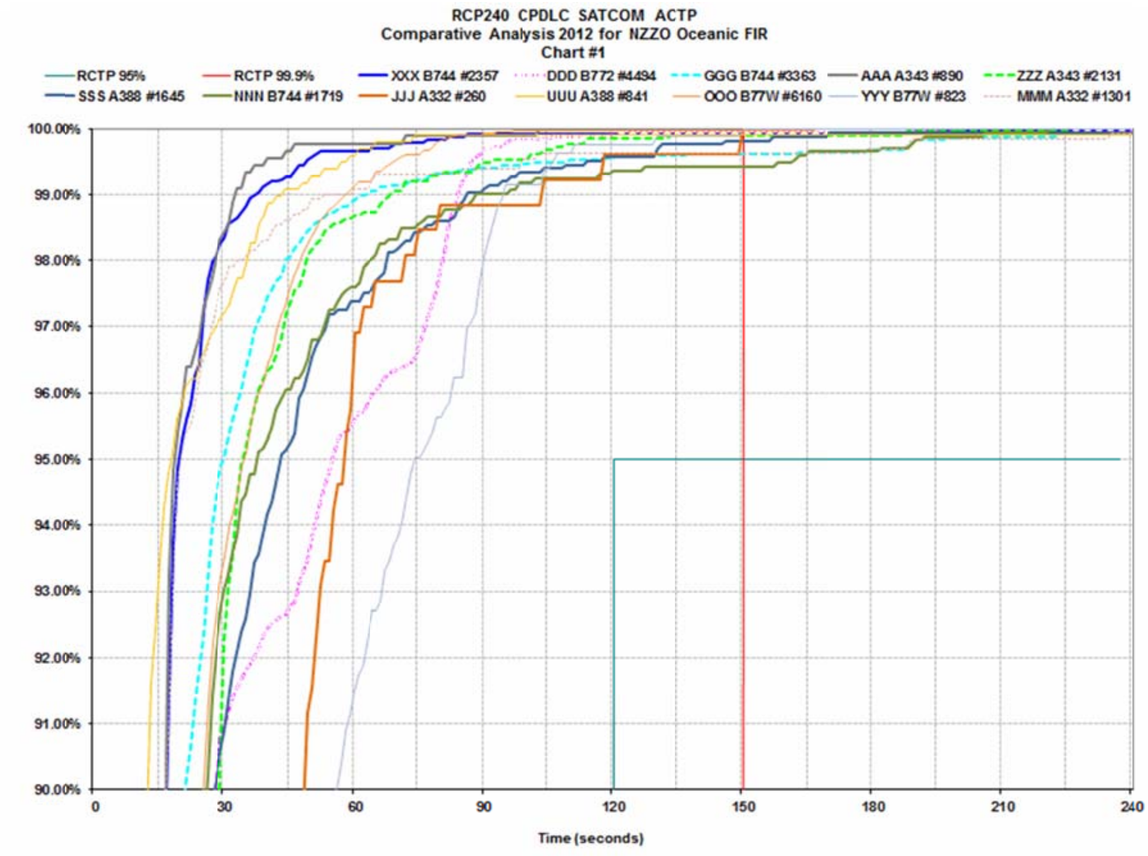


Figure D- 10. CPDLC ACTP comparative operator type performance

D.1.3.4 ADS-C surveillance data transit time analysis

Monitoring of ADS-C surveillance data transit time involves an assessment of observed delay from a graphical analysis of data using the structure outlined in paragraph 0.

D.1.3.4.1 Monitoring communications media performance

Graphs illustrating ADS-C surveillance data transit time are used to assess performance through the various communications media. The graphs depict measured performance against the surveillance requirements at the 95% and 99.9% level. An analysis is completed for:

a. Data from all aircraft via all remote ground station (RGS) types.

b. Data from all aircraft via SATCOM RGS

c. Data from all aircraft via VHF RGS

d. Data from all aircraft via HF RGS

e. Data from all aircraft via combined HF and SATCOM RGS

A typical graph illustrating ADS-C surveillance data transit time observed from SATCOM and constructed using a spreadsheet application is illustrated in Figure D- 11. Similar graphs are used to assess delay through individual communications media.

Figure D- 11 graphs ADS-C surveillance data transit time against the 95% 90-second and 99.9% 180-second requirements for the RSP specification provided in Appendix C, paragraph C.2 using the ADS-C transactions recorded during the period 2009 -2012 in the NZZO FIR.

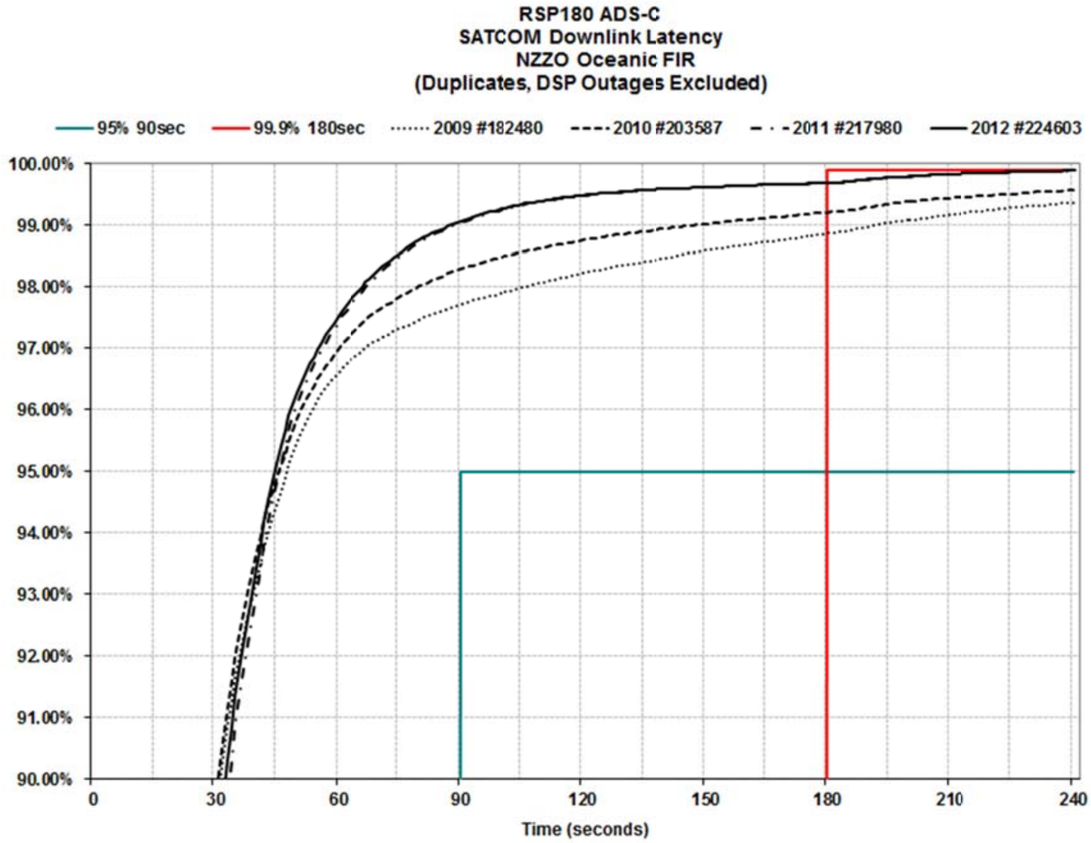


Figure D- 11. ADS-C via SATCOM NZZO FIR 2009 – 2012

D.1.3.4.2 Monitoring operator fleet performance

Graphs illustrating ADS-C surveillance data transit time can be used to monitor the performance of each aircraft type in an operator's fleet. These should be maintained on a monthly basis and can be used to observe the performance of each type when using different media such as: via SATCOM; via SATCOM + HF; via HF; via VHF; and via all RGS. The January to May 2009 SATCOM delay analysis of the A343 fleet for an operator in the NZZO FIR is illustrated in Figure D- 12.

Figure D- 12 graphs ADS-C surveillance data transit time against the 95% 90-second and 99.9% 180-second requirements for RSP 180D using the 3195 ADS-C downlinks recorded for the fleet during the period January-May 2009. Considerable performance variation may be seen month to month on some fleets and significant degradation in any month may be the result of poor performance from an individual aircraft or may be the result of routes changing month to month with varying weather patterns. These may be investigated further using an analysis of individual tails in a fleet as discussed in D1.3.5 below. The fleet illustrated shows little variation between the months and for clarity only the high and low months are depicted. Over a number of years a representative picture of the expected performance for a fleet will emerge. This assists in detecting any performance degradation. Figure D- 13 illustrates observed yearly performance for the same fleet from 2009-2012.

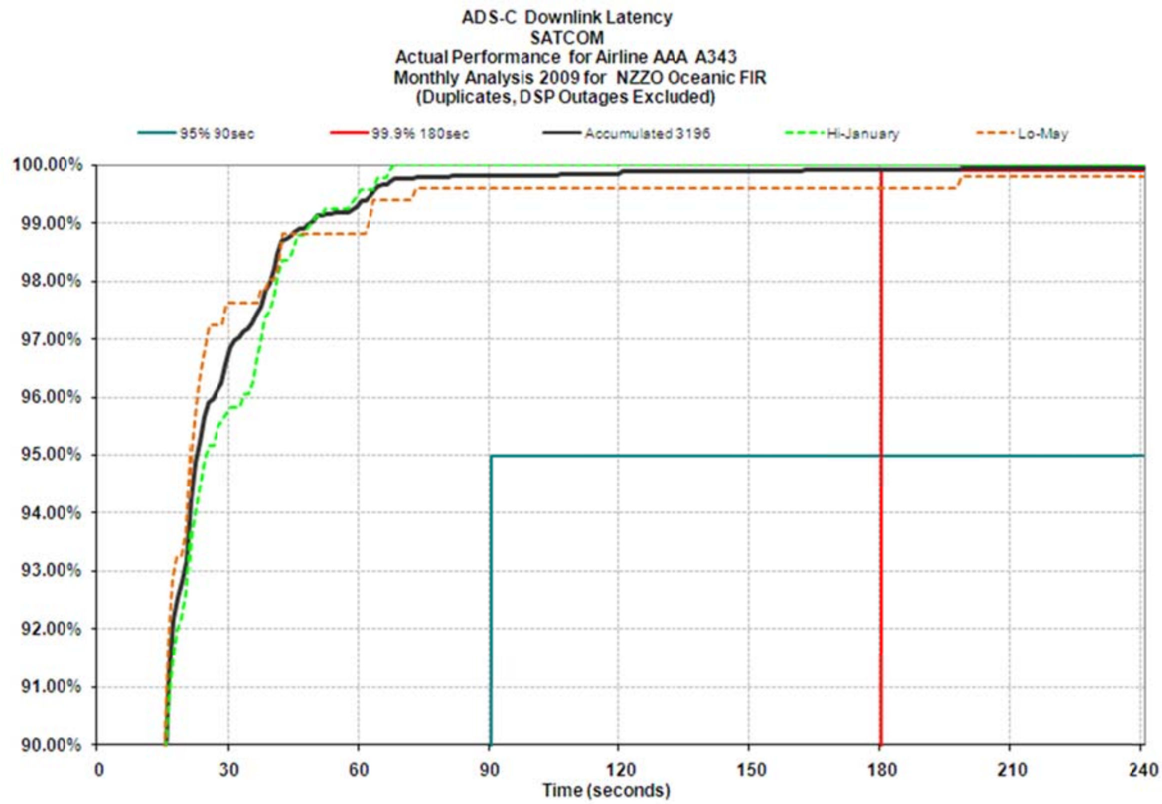


Figure D- 12. ADS-C A343 AAA via SATCOM NZZO FIR Jan – May 2009

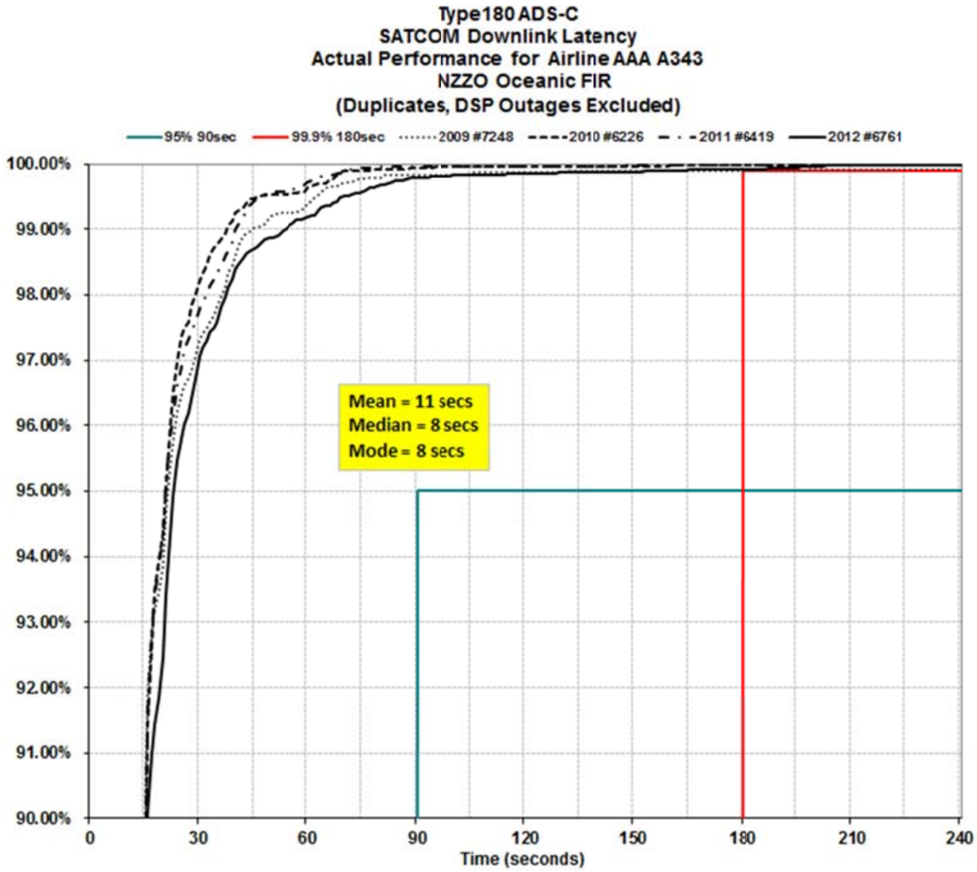


Figure D- 13 ADS-C A343 AAA via SATCOM NZZO FIR 2009-2012

A comparative analysis of the performance of different fleets operating in an ATSU's airspace particularly of fleets of the same type is useful. Under performing fleets can be identified for further analysis and a picture of typical performance from all fleets can be built up. These can be compared with the same fleets operating in other ATSUs' airspace.

Figure D- 14 below graphs SATCOM transit times for a number of fleets operating in NZZO FIR for the period January – May 2009. Significant variations in observed performance such as with operator DDD B772 fleet can be flagged for further analysis as discussed in paragraph D.1.3.5.

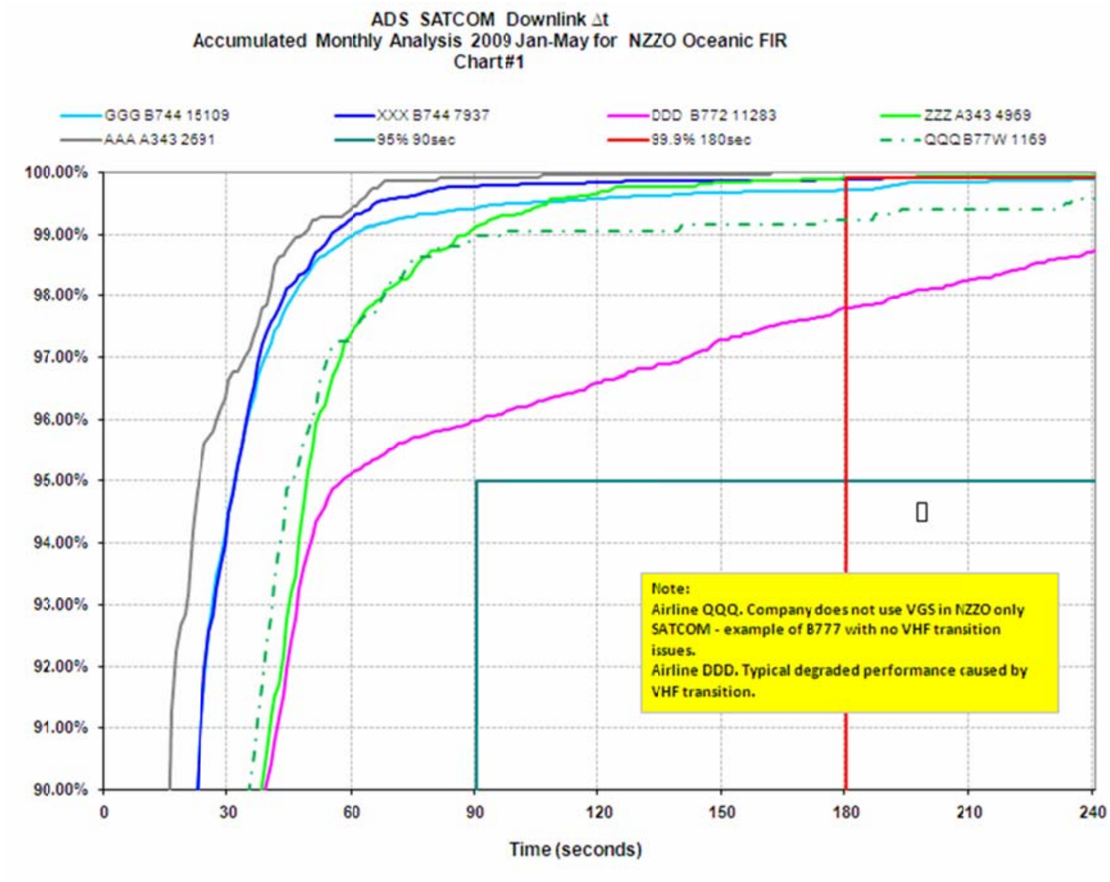


Figure D- 14. Comparative SATCOM ADS-C for different operators

The issue affecting operator DDD B772 fleet in Figure D- 14 was identified by the regional CRA as an aircraft issue that affected all B777 aircraft. This was eventually resolved by a software upgrade. ANSP should note that software upgrades to aircraft may take some time to be implemented by all airlines. The current performance of operator DDD B772 fleet is depicted in Figure D- 15.

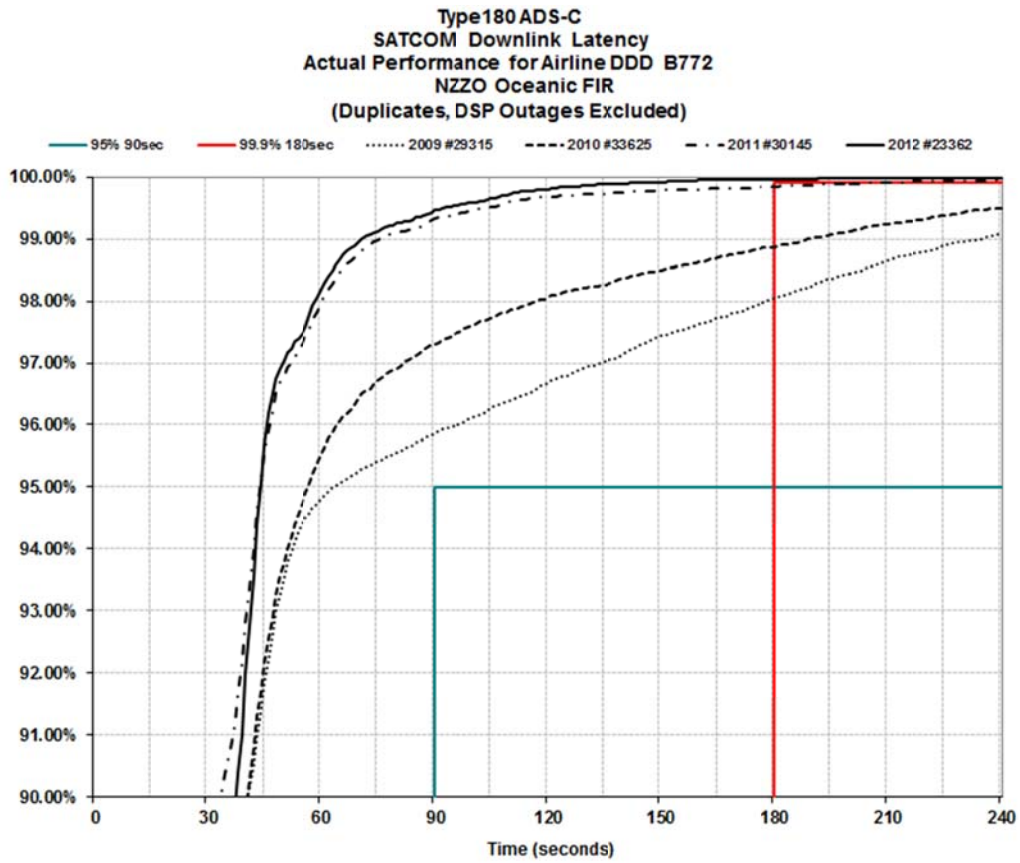


Figure D- 15 SATCOM ADS-C Operator DDD B777 2009-2012

D.1.3.5 Identifying poor performers

The reasons behind degraded performance are many and varied. Considerable analysis may be required before the reasons behind poor performing fleets are identified and it is difficult to provide guidance for all situations. Some analysis techniques that have been used by some ANSP with some success to identify reasons behind poor performance are provided in the following paragraphs.

On a number of occasions poor performance has been attributed to a specific aircraft in a fleet. Usually these poor-performing aircraft can be identified by the visual inspection of monthly data ordered in terms of transit time, or more accurately by graphing the monthly data for a fleet by aircraft registration.

Techniques such as graphing the positions of all delayed messages on a geographical display have identified areas for further investigation.

There are low speed (600 bps and 1200 bps) and high speed (10500 bps) data rates defined for the P, R, and T SATCOM channels. Some aircraft are capable of low speed SATCOM only. Other aircraft are capable of both high speed and low speed. However, not all aircraft that are

capable of high speed operation have enabled the use of high speed SATCOM and, instead operate in low speed only. It is recommended an operator using low speed SATCOM channels change to the high speed channels where possible. Low or high speed channel use is selectable by an individual operator in the aircraft operational requirements table (ORT).
Significant performance benefits accrue with the use of the high speed channels as illustrated in the figure D-10 below.

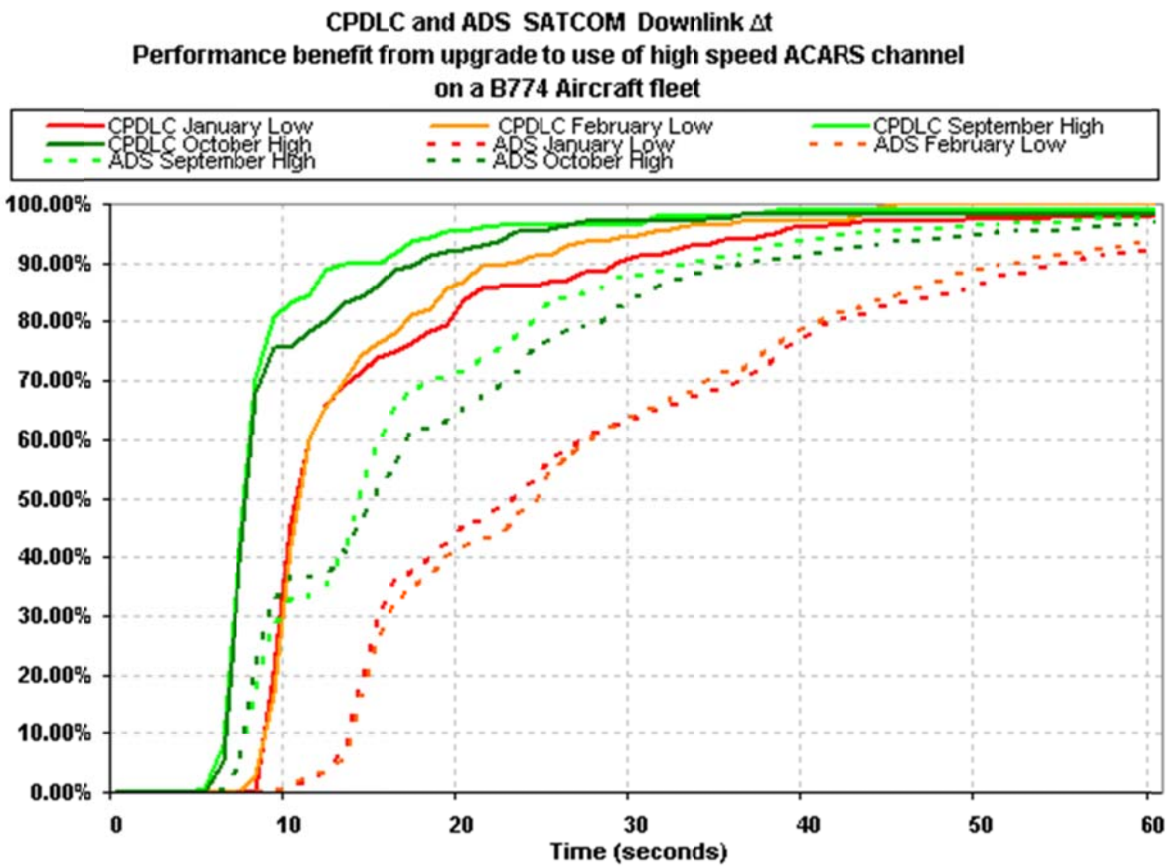


Figure D- 16. Effect of ACARS channel speed on ADS-C surveillance data transit time

An ANSP can assess ACARS channel speed use by evaluating the monthly downlink times for ADS-C reports via SATCOM. For users of high speed channels ANSP will consistently see a small percentage of reports in the 6-8 second time bands. Low speed channels users usually have very few reports less than 10 seconds.
ANSP should identify those operators using the low speed channels and stakeholders should work with those operators to achieve an upgrade to the high speed channels.

D.1.3.6 Assessing periodic monitoring results

The 95% and 99.9% criteria are provided as operationally significant benchmarks against which the surveillance and communication applications supporting ATM functions can be assessed.

Typically post implementation monitoring is carried out on a monthly basis and observed performance assessed to detect any performance degradation.

D.1.3.6.1 99.9% Criteria

The 99.9% criteria define the Expiry Time (ET) for communication transactions and the Overdue Time (OT) for surveillance transactions following which the initiator is required to revert to an alternative procedure. When using data link to provide reduced separations the RCP240 ET and RSP180 OT are the times after which if a CPDLC intervention transaction is not completed or an ADS-C position report is not received then the controller is obliged to revert to alternative separation procedure as defined in the separation specification. If monthly monitoring shows that a specific fleet is not meeting the criteria then a local safety assessment by the ANSP should be carried out to assess if the reduced separation standard can continue to be applied. Some ANSP have set monitoring guidelines as to trigger a safety assessment and further investigation. The safety assessment would consider the density of traffic and traffic patterns flown in the region together with the frequency of application of the reduced separation to assess whether the increased probability of having to revert to an alternative separation would have workload and thus safety implications for the controllers. The safety assessment would also consider the performance of other fleets operating in the airspace.

D.1.3.6.2 95% Criteria

The 95% criteria define the nominal time acceptable for normal CPDLC and ADS-C operations. If monthly monitoring shows that measured performance is consistently below the 95% criteria then consideration may be given to the withdrawal of data link services to the fleet. Experience has shown that observed fleet performance below the specified RCP240/RSP180 95% criteria will usually be accompanied by controller complaints of unacceptable performance by that fleet.

D.1.3.6.3 Setting Guidelines

In airspace where procedural separation is being applied, it has been observed that complete withdrawal of datalink may not be required even if performance is observed to fall below the RCP240/RSP180 criteria. While safety services such as reduced separation standards requiring RCP240/RSP180 would be withdrawn the observed performance may still meet RCP/RSP400 criteria and the local safety assessment may also conclude that maintaining the data link connection is viable.
Some ANSP have set monitoring guidelines to assist with their data analysis. These include:

a. If the performance observed for a fleet by monthly monitoring at the 99.9% level is better than 99.75% then the fleet is considered to meet the 99.9% performance level.

b. Observed fleet performance consistently falling below 99.0% will be subject to CRA problem reports and investigation that will attempt to determine the cause of the degradation.

c. Any monthly performance degradation (0.5%) by a fleet below observed historical performance will be subject to investigation.

D.1.3.6.4 Case Study

In early 2009 analysis of the performance data for December 2008 in NZZO detected a slight performance degradation for both ADS-C and CPDLC against the monitored RCP240/RSP180 standard. Further performance deterioration was observed mid February 2009 when the January 2009 data was assessed.

During this period further local analysis was initiated and by March 2009 a CRA problem report had been raised and a full investigation was underway by the CRA and the CSP's. Further deterioration in performance was noted in the following months through to October 2009.

ADS-C performance for the fleet as measured against the RSP180 performance standard is illustrated in Figure D-17 and CPDLC performance as measured against the RCP240 performance standard is illustrated in Figure D-18.

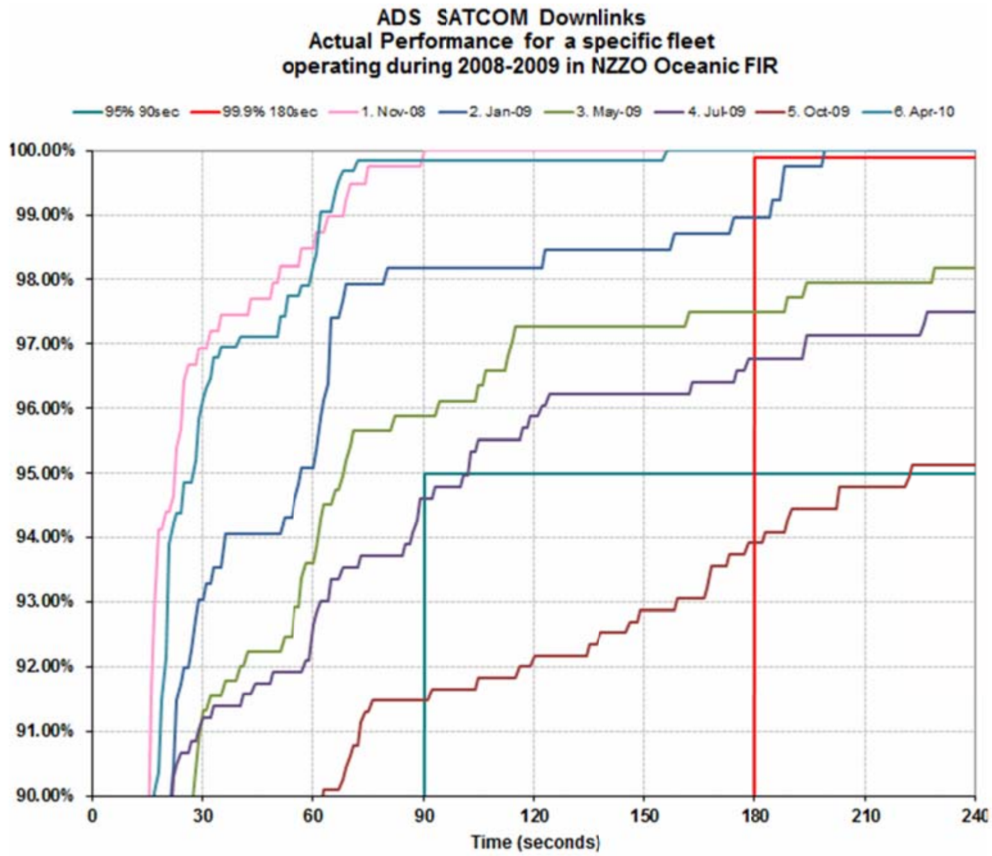


Figure D- 17 Example of ADS-C performance deterioration

A safety assessment in early 2009 concluded that reduced separation standards using datalink would be withdrawn although CPDLC and ADS-C would continue to be used.

The cause of the problem was identified in mid 2009 as a system level GES issue. This was caused by the implementation of new cabin services on the aircraft that were gradually installed on the fleet from late 2008 until the middle of 2009. This explained the continuing performance degradation through this period.

A software fix was released in early 2010 with observed performance levels for the fleet returning to normal immediately and meeting the RSP180/RCP240 standard.

Reduced separation standards were restored to the fleet in April 2009 after monitoring had demonstrated that performance standard compliance had been achieved.

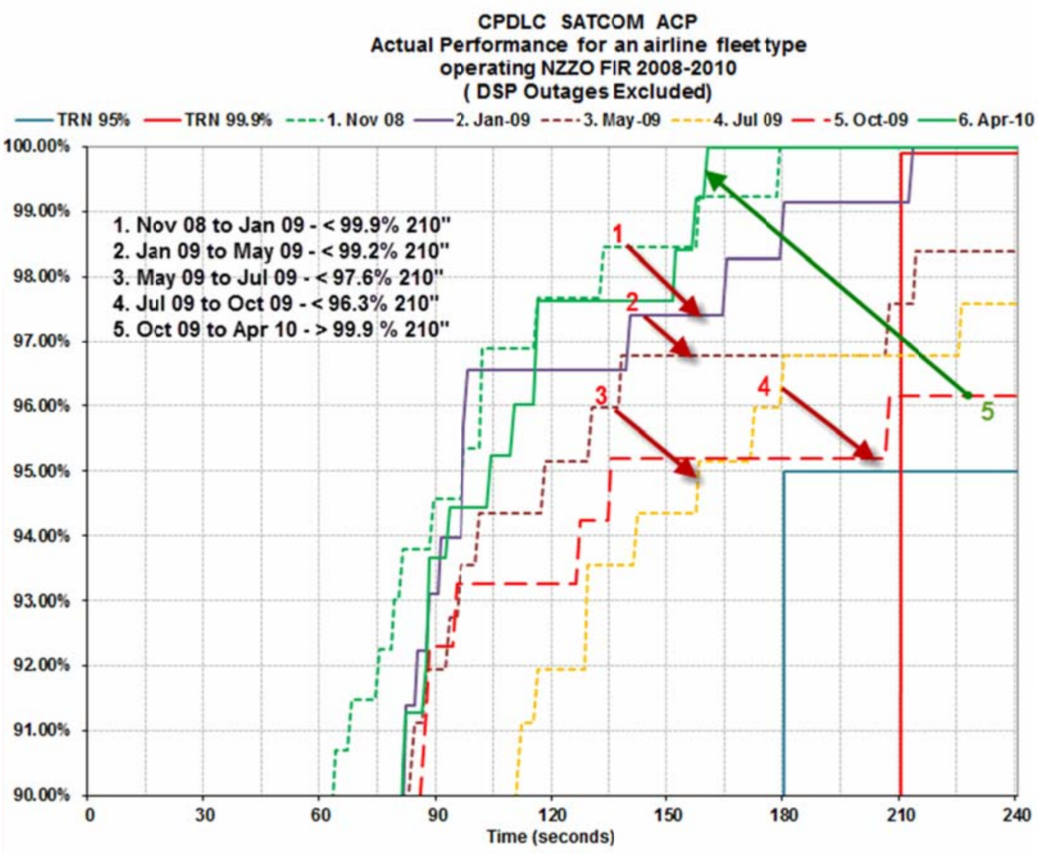


Figure D- 18 Example of CPDLC ACP performance deterioration

D.2 Problem reporting and resolution

D.2.1 General

The working principles in this guidance material result from the combined experience of the North Atlantic, Asia-Pacific, South American, African-Indian Ocean, and European Regions. Many regions have formed a regional monitoring agency to manage the problem reporting and resolution process.

All stakeholders should be actively involved in the problem reporting and resolution process. It is essential that all aircraft operators in a region have the opportunity to become involved in the process and CRA's should be pro-active in getting all aircraft operators and other stakeholders to register and participate in the process.

The problem identification and resolution process, as it applies to an individual problem, consists of a data collection phase, followed by problem analysis and coordination with affected parties to secure a resolution, and recommendation of interim procedures to mitigate the problem in some instances. This is shown in the Figure D- 19.

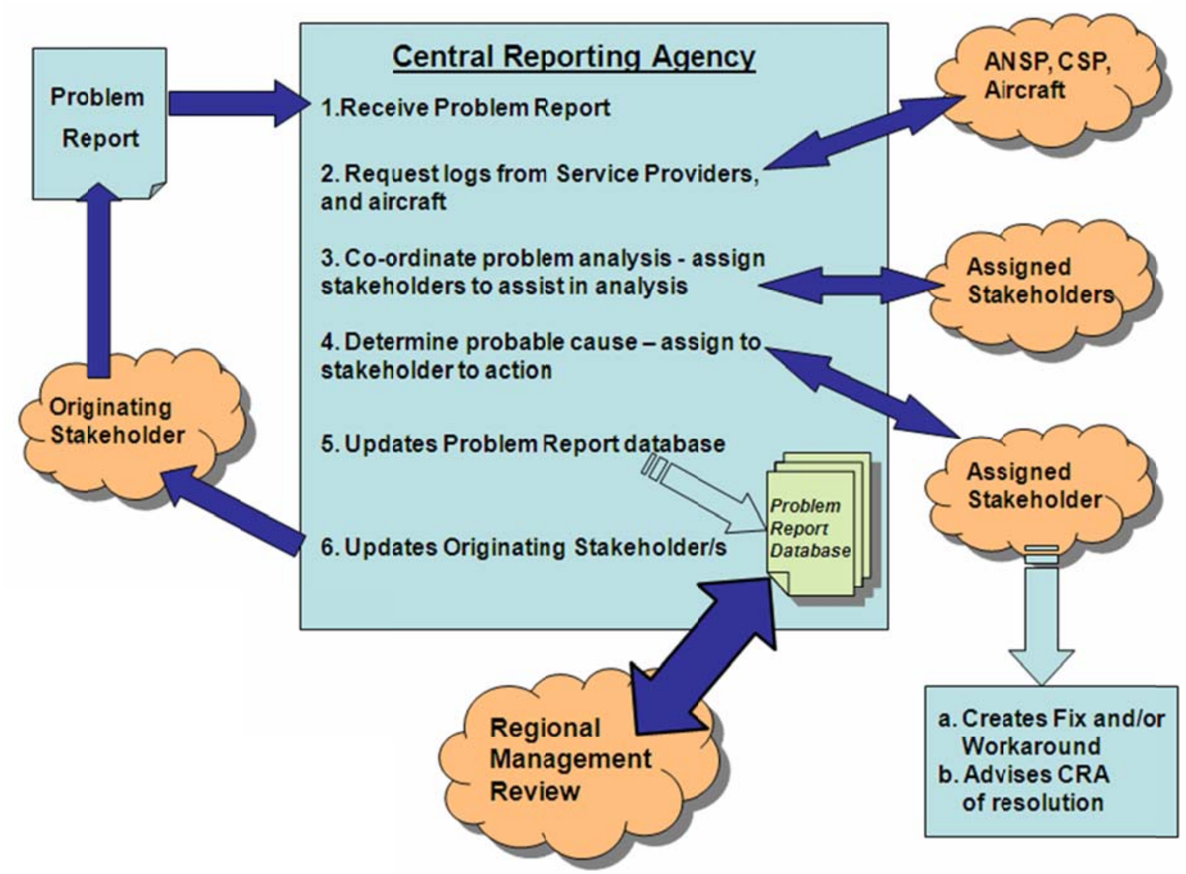


Figure D- 19. Problem reporting and resolution process

D.2.2 Problem report form

The problem identification task begins with receipt of a problem report from a stakeholder, usually an operator, ANSP or CSP but may include aircraft or avionics manufacturers. Standard reporting forms should be developed and regions should investigate the use of a website to receive and store problem reports.
As an example, the EUR region uses JIRA (http://www.eurocontrol.int/link2000/wiki/index.php/), a secured web-based problem reporting and tracking application, which is managed by the LINK2000+/Central Reporting Office of EUROCONTROL. Problems should be reported, regardless whether it can be resolved locally or needs to be handled to promote knowledge sharing across the data link community.
An example of an online problem reporting form currently used on-line by regional CRA in the NAT, and Asia Pacific regions is shown in Figure D- 20. The fields used in the form are as follows:

a. Originator's Reference Number: Originators problem report reference (e.g. ANZ_2009-23);

b. Title: A short title which conveys the main issue of the reported problem (e.g. CPDLC transfer failure);

c. Date UTC: Date in YYYYMMDD format (e.g. 20090705);

d. Time UTC: Time in HHMM (e.g. 2345);

e. Aircraft registration: ICAO flight plan aircraft registration (e.g. ZKADR);

f. Aircraft identification: ICAO flight plan call sign if applicable (e.g. NZA456);

g. Flight Sector: If applicable the departure and destination airfield of the flight (e.g. NZAA-RJBB);

h. Organization: Name of the originators organization (e.g. Airways NZ);

i. Active Center: Controlling Centre at time of occurrence if applicable (e.g. NZZO);

j. Next Center: Next controlling centre at time of occurrence if applicable (e.g. NFFF);

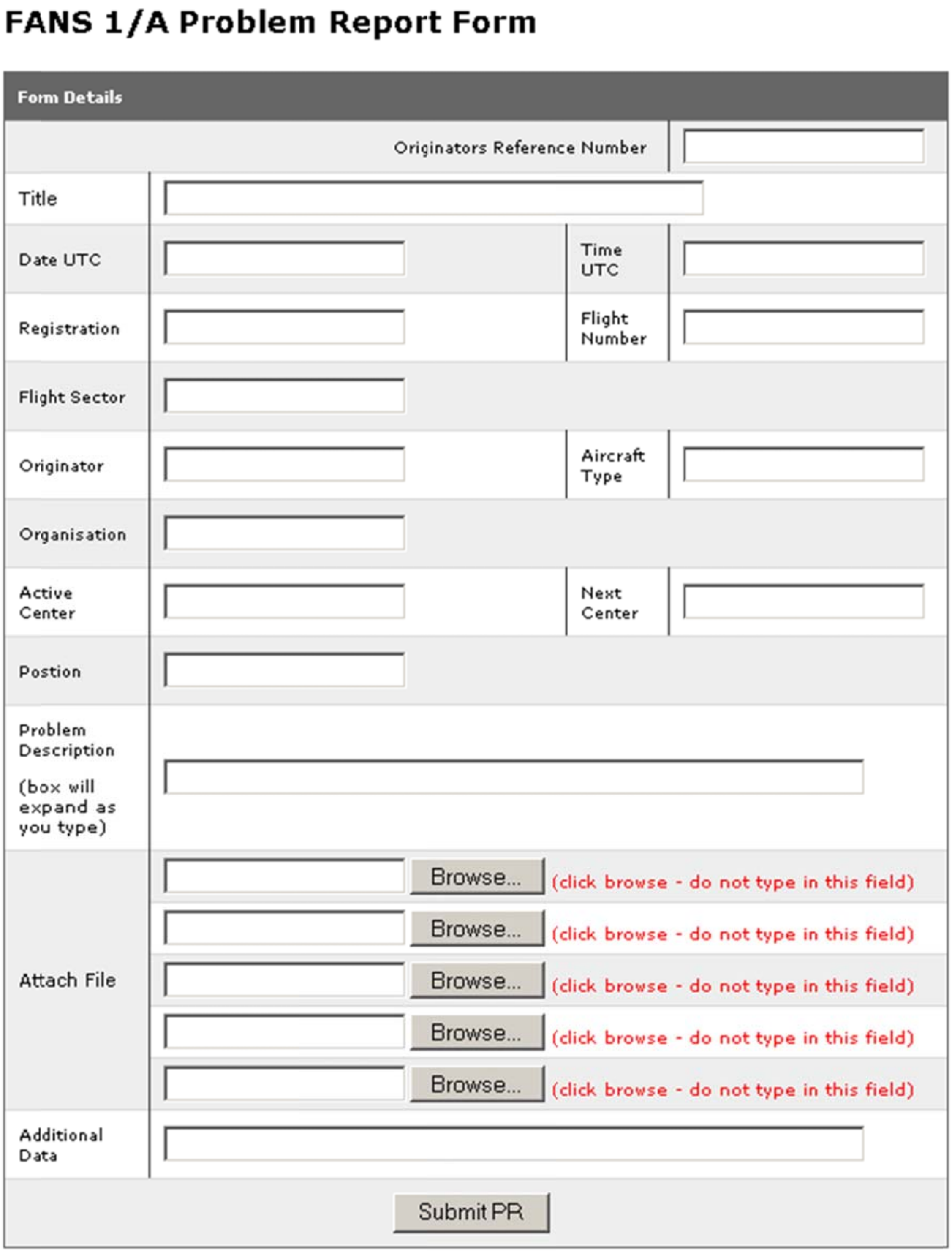
k. Position: Position of occurrence (e.g. 3022S16345E);

l. Problem Description: Detailed description of problem;

m. Attach File: Area of web page where originator and assigned stakeholders can attach data files or other detailed information such as geographic overlays; and

n. Additional Data: Area set aside for feedback from stakeholders assigned by the regional/State monitoring agency. This will includes the results of the investigation and the agreed action plan.

Note.— A number of regional monitoring agencies are developing websites to manage the problem reporting process. Website addresses and the regional monitoring agency to which they are applicable are listed in Appendix E.



FANS 1/A Problem Report Form

Form Details

Originators Reference Number			
Title			
Date UTC		Time UTC	
Registration		Flight Number	
Flight Sector			
Originator		Aircraft Type	
Organisation			
Active Center		Next Center	
Postion			
Problem Description (box will expand as you type)			
Attach File	Browse... (click browse - do not type in this field)		
	Browse... (click browse - do not type in this field)		
	Browse... (click browse - do not type in this field)		
	Browse... (click browse - do not type in this field)		
	Browse... (click browse - do not type in this field)		
Additional Data			

Submit PR

Figure D- 20, Example on-line problem reporting form

D.2.2 Problem assessment

D.2.2.1 Data collection

D.2.2.1.1 The data collection phase consists of obtaining message logs from the appropriate parties (which will depend on which ANSPs and CSPs were being used and operator service contracts). Today, this usually means obtaining logs for the appropriate period of time from the CSPs involved. Usually, a log for a few hours before and after the event that was reported will suffice, but once the analysis has begun, it is sometimes necessary to request additional data, (perhaps for several days prior to the event if the problem appears to be an on-going one).

D.2.2.1.2 Additionally, some aircraft-specific recordings may be available that may assist in the data analysis task. These are not always requested initially as doing so would be an unacceptable imposition on the operators, but may occur when the nature of the problem has been clarified enough to indicate the line of investigation that needs to be pursued. These additional records include:

a. Aircraft maintenance system logs.

b. Built-In Test Equipment data dumps for some aircraft systems.

c. SATCOM activity logs.

d. Logs and printouts from the flight crew and recordings/logs from the ANSPs involved in the problem may also be necessary. It is important that the organization collecting data for the analysis task requests all this data in a timely manner, as much of it is subject to limited retention.

D.2.2.2 Data analysis

D.2.2.2.1 Once the data has been collected, the analysis can begin. For this, it is necessary to be able to decode all the messages involved, and a tool that can decode every ATS data link message type used in the region is essential. These messages include:

a. AFN (ARINC 622), ADS-C and CPDLC (RTCA DO-258/EUROCAE ED-100) in a region operating FANS-1/A.

b. Context Management, ADS-C and CPDLC applications (ICAO Doc 9705 and RTCA DO-280B/ED-110B) in a region using ATN B1.

c. ARINC 623 messages used in the region.

D.2.2.2.2 The analysis of the decoded messages requires a thorough understanding of the complete message traffic, including:

a. Media management messages.

b. Relationship of ground-ground and air-ground traffic.

c. Message envelope schemes used by the particular data link technology (ACARS, ATN, etc).

D.2.2.2.3 The analyst must also have a good understanding of how the aircraft systems operate and interact to provide the ATS data link functions, as many of the reported problems are aircraft system problems.

D.2.2.2.4 This information will enable the analyst to determine a probable cause by working back from the area where the problem was noticed to where it began. In some cases, this may entail manual decoding of parts of messages based on the appropriate standard to identify particular encoding errors. It may also require lab testing using the airborne equipment (and sometimes the ground networks) to reliably assign the problem to a particular cause.

D.2.2.2.5 Once the problem has been identified, then the task of coordination with affected parties begins. The stakeholder who is assigned responsibility for fixing the problem must be contacted and a corrective action plan agreed. The stakeholder who initiated the problem report shall be provided with regular updates on the progress and resolution of the problem

D.2.2.2.6 This information (the problem description, the results of the analysis and the plan for corrective action) is then entered into a database covering data link problems, both in a complete form to allow continued analysis and monitoring of the corrective action and in a de-identified form for the information of other stakeholders. These de-identified summaries are reported at the appropriate regional management forum and made available to other regional central reporting/monitoring agencies on request.

D.2.3 Mitigating procedures – problem resolution

The regional monitoring agency's responsibility does not end with determining the cause of the problem and identifying a fix. As part of that activity, and because a considerable period may elapse while software updates are applied to all aircraft in a fleet, procedural methods to mitigate the problem may have to be developed while the solution is being coordinated. The regional monitoring agency should identify the need for such procedures and develop recommendations for implementation by the ANSPs, CSPs and operators involved.

D.3 Regional performance monitoring

This section provides guidance on periodic reporting by individual ANSP of observed system performance in their airspace that will enable regional performance metrics to be developed for the availability, CPDLC transaction time and ADS-C surveillance data transit time requirements specified in Appendix B and Appendix C. These regional performance metrics should be made available to all interested stakeholders. The use of regional websites to enhance the distribution of these metrics should be considered. An example of such a website can be viewed at http://www.ispacg-cra.com/.

D.3.1 Periodic reporting

It is recommended that regions implement monthly performance reporting to obtain system performance metrics. These reports will provide data on observed availability, CPDLC transaction time and ADS-C surveillance data transit time as described herein.

D.3.1.1 Reporting on availability

ANSP should report on CSP notified system outages and on detected outages that have not been notified as described in paragraph D.1.3.2.1. This is used to calculate the actual availability of service provision.

For each outage the following information should be reported:

a. Time of CSP outage notification: In YYYYMMDDHHMM format or "Not Notified" if no CSP notification received.

b. CSP Name: Name of CSP providing outage notification if applicable.

c. Type of outage: Report media affected SATCOM, VHF, HF, ALL.

d. Outage start time: In YYYYMMDDHHMM format

e. Outage end time: In YYYYMMDDHHMM format

f. Duration of Outage: In minutes.

As per Appendix B only outages greater than 10 minutes are reported. An example form is shown in Figure D- 23.

For EUR region, the number of Provider Aborts experienced by the ANSP and manually reported availability problems affecting a single aircraft should be reported. This provides an acceptable indication of the actual Availability of Use.
ANSP can use graphical analysis to track availability as illustrated in Figure D- 21 and Figure D-22.

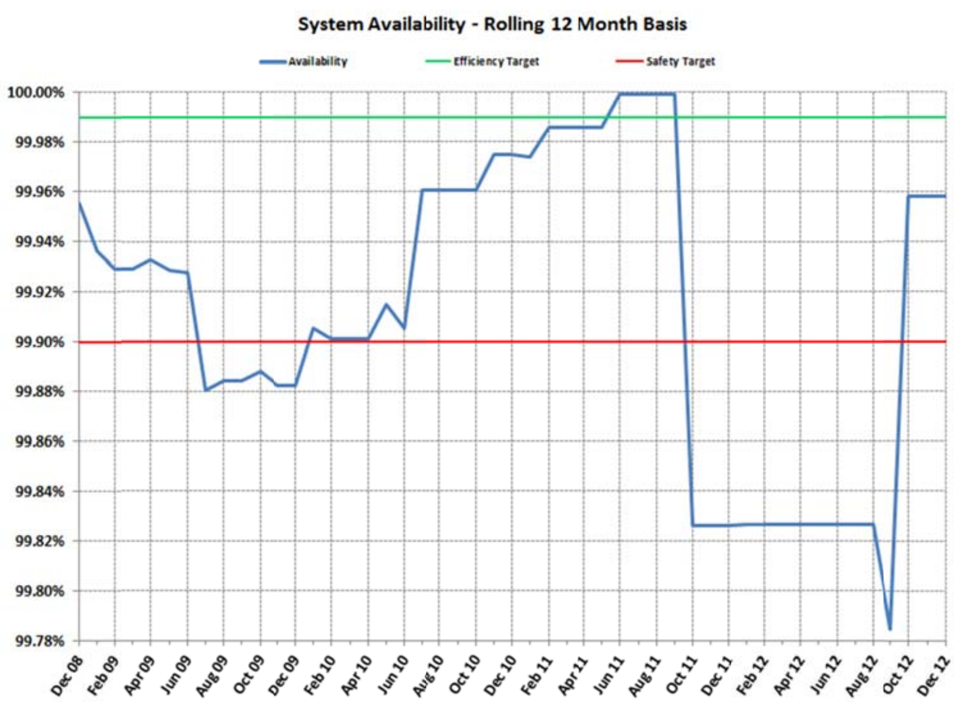


Figure D- 21 Example System Availability Graph

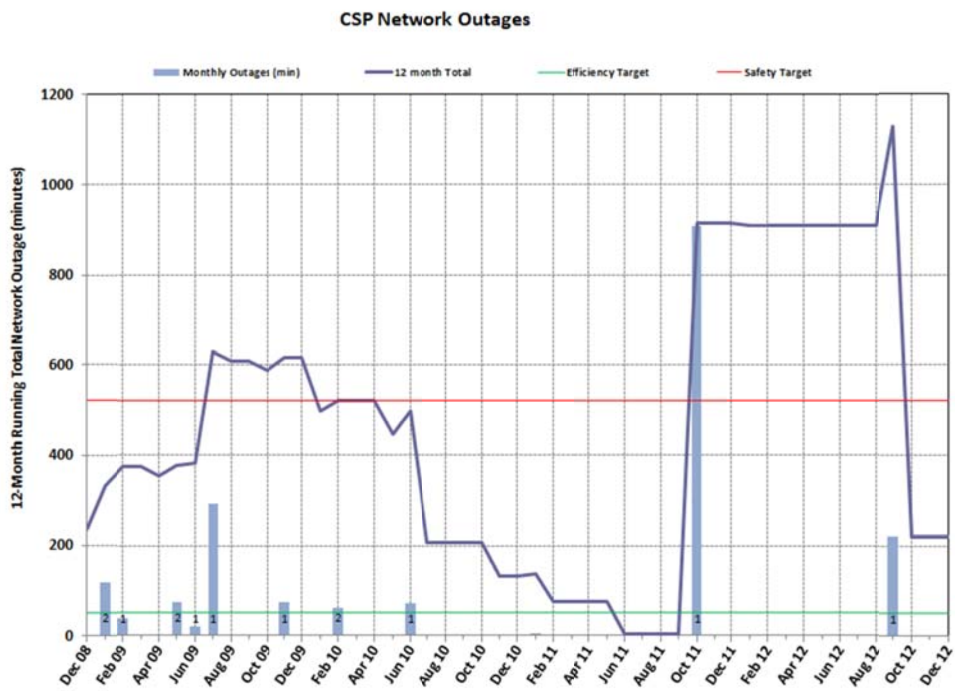


Figure D- 22 Example Network Outage Graph

D.3.1.2 Reporting on CPDLC actual communications performance

ANSP should report observed ACP and ACTP for RCP240 and RCP400 for different media paths using all transactions involving a WILCO response as described in paragraph 0. The media paths to report are:

a. From all aircraft via all remote ground station (RGS) types.

b. From all aircraft where both uplink and downlink are via SATCOM RGS

c. From all aircraft where both uplink and downlink are via VHF RGS

d. From all aircraft where both uplink and downlink are via HF RGS

e. From all aircraft where either uplink and downlink are via HF or SATCOM RGS

A tabular reporting format can be used to capture the observed performance at the 95% and 99.9% RCP240/400 times.

As PORT is independent of media path, this need only be reported for all RGS types. An example form is shown in Figure D- 23.

ANSPs within the EUR region record the DLIC-Contact/CPDLC log files for ACP and ACTP and ATN B1 transport level log files, deployment and system health log files in the standardised XML-format as described in paragraph D.1.1.2. All ANSPs send the log files to the CRO for importing into PRISME (Pan-European Repository of Information Supporting the Management of EATM). PRISME is an integrated ATM data ware house for creation of various performance