Post-Implementation Monitoring Requirements and Creating PBCS Data Files

Global Operational Data Link (GOLD)

Familiarization with Performance Based Communications and Surveillance (PBCS) Workshop

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FAA

Federal Aviation Administration

Overview

- Data Collection Guidance
- Availability Data
- CPDLC Data Collection
- ADS-C Data Collection
- Filtering CPDLC and ADS-C data
- Calculating Monitoring Parameters
- Analysis Examples from the PBCS Manual
- Summary

Data Collection Guidance

PBCS Manual Doc 9869 Appendix D.1

- Appendix D provides guidance additional to that provided in Chapter 5, for local and regional PBCS monitoring programmes. It contains the post-implementation guidance material relevant to CPDLC and ADS C for which the RCP/RSP specifications provided in Appendix B and Appendix C are applicable, including:
  - ANSP data collection – This section defines a common data reporting format, providing guidance on how to obtain the necessary data points.
  - ANSP monitoring and analysis – This section contains guidance on data analysis, including recommended filtering for completeness of monitoring.
  - Regional performance monitoring and analysis – This section provides guidance on monitoring at a regional level.
  - Problem reporting and resolution – This section provides guidance on the process for problem identification and resolution.

Administering PBCS Monitoring Programs
PBCS 4.5.1.2-4 (Compressed – See ANSP Session)

- The ANSPs within a region should identify the entity and focal point(s) for administering the regional PBCS monitoring programme
  - The ANSPs within a region should establish the policies and procedures should establish the policies and procedures for administering the program including:
  - Formats, intervals ,collecting data, maintaining data monitoring and analyzing data, investigating problem reports, and coordinating corrective actions, tracking and resolving problems.

CPDLC and ADS-C availability

PBCS Manual Doc 9869 Appendix D.2.3

- The ANSP should collect data on CSP notified system outages as well as detected outages that are not observed by or notified by the CSP as these data are used to calculate the actual availability of CPDLC and ADS-C.
- For each outage the following information should be collected:
  - Time of CSP outage notification: In YYYYMMDDHHMM format or “Not Notified” if no CSP notification received.
  - CSP Name: Name of CSP providing outage notification if applicable.
  - Type of outage: Report media affected SATCOM, VHF, HF, ALL.
  - Outage start time: In YYYYMMDDHHMM format.
  - Outage end time: In YYYYMMDDHHMM format.
  - Duration of Outage: In minutes
    - As per Appendix B only outages greater than 10 minutes are reported.
- The data sets should also be examined to identify the cases of outages not detected or notified by the CSP.
  - For example, when delays are observed from multiple aircraft and the messages are received by the ANSP at similar times, this may indicate a system outage.

Monitoring Report Sample

PBCS Manual Doc 9869 Appendix Table D-7

Example Service Availability local PBCS Monitoring Report

PBCS Monitoring Report – Service Availability				
ANSP/CTA →	ANSP1/CTA1	**Period →**	1 Jan to 30 Jun 2014 (6 months)	
Specification →	RCP 240/RSP 180	**Application →**	CPDLC/ADS-C	
CSP notification	**CSP name**	**Outage type**	**Start time**	**Duration (minutes)**
200907150005	CSP1	SATCOM	200907150001	19
Not notified	N/A	SATCOM	200907212233	22
200907281515	CSP2	VHF	200907281510	15
. . .				

CPDLC Data Collection

CPDLC Transaction Time/Continuity

PBCS Manual Doc 9869 Appendix D.2.1.1

- ANSP data collection is needed for CPDLC transaction time/continuity calculations
- For the purpose of sharing CPDLC transaction data the data should be sent as a comma delimited text file. The format for each record will contain, at minimum the 20 data points specified.
  - The CPDLC data set is comprised of controller-initiated transactions, specifically the subset of CPDLC uplinks that receive a single DM 0 WILCO response are used.
    - The transactions in which an uplink receives DM 1 UNABLE, DM 2 STANDBY, DM 3 ROGER, DM 4 AFFIRM, DM 5 NEGATIVE responses are not considered. A DM 0 WILCO response following a DM 2 STANDBY is also not measured.

CPDLC Transaction Time/Continuity

PBCS Manual Doc 9869 Appendix D.2.1.2

- Recording data points for each CPDLC transaction
  - Recommended data points should be extracted by the ANSP from CPDLC system recordings to provide sufficient information for RCP analysis and problem investigation.
  - Most of the data points can be extracted from either the ACARS or ATN B1 header or the CPDLC application message, or calculated based on the other data points.
    - However, the aircraft type and operator will need to be matched to each record from a separate database using the aircraft registration as the common point.

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.
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 AircraftCPDLCPDU, timestamp in the decoded operational response message.

Ref	Label	Description and/or remarks
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 Error! Reference source not found. above. When graphing PORT negative values should be counted as 0.
20	COMTYP	Data link communication type, e.g. SAT Note.— The nine possible entries for COMTYP are SAT, VHF, HF, SV, SH, VS, VH, HS, HV. Value is based on the MAS RGS field (#6) and OPS RGS (#7). See Table 2. Satellite (SAT), Very High Frequency (VHF), High Frequency (HF)

CPDLC Uplink (Sample Data)

ACARS Transmission of CPDLC uplink

QU FANS1XA

.NYCODYA 010002

ATC

AN N754AN/MA 707A

- /NYCODYA.AT1.N754ANA300288732BC0B581CAF548544AB15054A506346930C93EA

ACARS Transmission of Message Assurance (MAS) from ARINC

QU NYCODYA

.FANS1XA 010002

MAS

AN N754AN/MA 707S

DT DDL XXW 010002 S11A

ATOP Decoded CPDLC Message

Jun 1 2017 12:02:34:000AM|Jun 1 2017 12:02:38:286AM|AAL66|.N754AN|6|255|3|1|28|DESCEND TO REACH F380 BY 0045|28, 129, 169|DESCEND TO REACH F380 BY 0045,

REPORT LEVEL F380,

DUE TRAFFIC

CPDLC Downlink Response

ACARS Transmission of CPDLC downlink

Jun 1 2017 12:03:04:113AM|-2|ATC|708|A|

QU NYCODYA

.DDLXCXA 010003

ATC

FI AA66/AN N754AN

DT DDL XXW 010003 L15A

AT1.N754AN640C00B7009E50

ATOP Decoded CPDLC Message

Jun 1 2017 12:02:55:000AM|Jun 1 2017 12:03:04:113AM|AAL66|N754AN|8|6|1|1|0|WILCO|0|WILCO

CPDLC Data Format

PBCS Manual Doc 9869 Appendix D

KZNY, N754AN, B772, AAL,
20170601, XXW, XXW, 00:02:34,
00:02:38, 4, 00:02:55,
00:03:04, 30, 9,
U28 U129 U169 D0, 11.0, 30.0,
19.0, SAT

CPDLC Data Format

PBCS Manual Doc 9869 Appendix D (Labeled)

(1) KZNY, (2) N754AN,(3) B772,(5) AAL,
(6) 20170601, (7) XXW,(8) XXW,(9) 00:02:34,
(10) 00:02:38,(11) 4,(12) 00:02:55,
(13) 00:03:04,(14) 30,(15) 9,
(16) U28 U129 U169 D0,(17) 11.0,(18) 30.0,
(19) 19.0, (20) SAT

Multiple Entries in Periodic Files

KZAK,XX5835 ,B737,CNV,20111101,XXC ,XXC ,23:14:55,23:15:08, 13,23:15:36,23:15:47, 52, 11,U33,DM0, 17.5, 52.0, 34.5,SAT
KZAK,XX978S ,K35R,TOR,20111101,XXC ,XXC ,13:03:36,13:04:01, 25,13:03:57,13:04:24, 48, 27,U20,DM0, 39.5, 48.0, 8.5,SAT
KZAK,XX141A ,C17 ,RCH,20111101,XXC ,XXC ,09:52:21,09:53:12, 51,09:53:20,09:53:42, 81, 22,U20,DM0, 47.5, 81.0, 33.5,SAT
KZAK,XX148A ,C17 ,RCH,20111101,XXC ,XXC ,22:43:02,22:43:13, 11,22:43:24,22:43:34, 32, 10,U20,DM0, 15.5, 32.0, 16.5,SAT
KZAK,XXMRM ,B772,MAS,20111101,POR1,POR1,13:35:28,13:35:35, 7,13:35:36,13:35:52, 24, 16,U82,DM0, 19.5, 24.0, 4.5,SAT
KZAK,XXMRM ,B772,MAS,20111101,POR1,POR1,14:09:56,14:10:03, 7,14:10:08,14:10:19, 23, 11,U82,DM0, 14.5, 23.0, 8.5,SAT
KZAK,XXMRM ,B772,MAS,20111101,POR1,POR1,14:11:24,14:11:30, 6,14:11:32,14:11:45, 21, 13,U26,DM0, 16.0, 21.0, 5.0,SAT
KZAK,XXMRM ,B772,MAS,20111101,POR1,POR1,08:36:44,08:36:52, 8,08:36:52,08:37:07, 23, 15,U20,DM0, 19.0, 23.0, 4.0,SAT
KZAK,XXMRM ,B772,MAS,20111101,POR1,POR1,12:29:07,12:29:14, 7,12:29:14,12:29:29, 22, 15,U82,DM0, 18.5, 22.0, 3.5,SAT
KZAK,XXSGB ,A345,SIA,20111101,POR1,POR1,06:40:42,06:40:46, 4,06:40:49,06:40:56, 14, 7,U30,DM0, 9.0, 14.0, 5.0,SAT
KZAK,XXSGB ,A345,SIA,20111101,POR1,POR1,08:31:06,08:31:10, 4,08:31:14,08:31:20, 14, 6,U30,DM0, 8.0, 14.0, 6.0,SAT
KZAK,XXSKB ,A388,SIA,20111101,POR1,POR1,16:53:32,16:53:38, 6,16:53:43,16:53:49, 17, 6,U20,DM0, 9.0, 17.0, 8.0,SAT
KZAK,XXSKB ,A388,SIA,20111101,POR1,POR1,17:50:29,17:50:33, 4,17:50:42,17:50:48, 19, 6,U20,DM0, 8.0, 19.0, 11.0,SAT
KZAK,XXSKD ,A388,SIA,20111101,POR1,POR1,03:16:36,03:16:40, 4,03:16:45,03:16:51, 15, 6,U20,DM0, 8.0, 15.0, 7.0,SAT
KZAK,XXSKD ,A388,SIA,20111101,POR1,POR1,05:15:17,05:15:21, 4,05:15:32,05:15:37, 20, 5,U20,DM0, 7.0, 20.0, 13.0,SAT
KZAK,XXSWG ,B77W,SIA,20111101,POR1,POR1,21:40:10,21:40:17, 7,21:40:23,21:40:34, 24, 11,U20,DM0, 14.5, 24.0, 9.5,SAT
KZAK,XXSWH ,B77W,SIA,20111101,APK1,APK1,01:26:16,01:27:52, 96,01:27:56,01:28:07, 111, 11,U82,DM0, 59.0,111.0, 52.0,SAT

ADS-C Data Collection

ADS-C Report Delivery Time/Continuity

PBCS Manual Doc 9869 Appendix D.2.2.1

- ANSP data collection for ADS C report delivery time/continuity
  - The ADS-C analysis is based on the measurement of actual surveillance performance (ASP) against the required surveillance performance (RSP). The ASP is the measurement of the difference between the time extracted from the decoded ADS-C basic group timestamp (i.e. time at position) and the time the ADS-C report is received at the ANSP.
- For the purpose of sharing CPDLC transaction data the data should be sent as a comma delimited text file. The format for each record will contain, at minimum the 12 data points specified
  - Data link communication type is a specified additional field and is useful in analyzing media transitions, and is added as a 13 field

CPDLC Transaction Time/Continuity

PBCS Manual Doc 9869 Appendix D.2.2.2

- Recording data points for each ADS-C Report transaction
  - Recommended data points should be extracted by the ANSP from CPDLC system recordings to provide sufficient information for RCP analysis and problem investigation.
  - Most of the data points can be extracted from either the ACARS header or the ADS C application message
    - The aircraft type and operator will need to be matched to each record from a separate database using the aircraft registration as the common point.

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.*
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.*

Ref	Label	Description and/or remarks
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).
13	COMTYP	Data link communication type, e.g. SAT *Note.— The three possible entries for COMTYP are SAT, VHF, HF. Value is based on the RGS field (#6). Satellite (SAT), Very High Frequency (VHF), High Frequency (HF)*

CPL (Current Flight Plan)

CPL-AAL66/A7141-IS

-B772/H-SDE1E3FGHIJ4J5M1RWXYZ/B1D1L

-KJFK-44N040W/0111F380

-M082F380 43N050W 44N040W 44N030W 44N020W DCT MUDOS DCT STG DCT

SUSOS UN725 RATAS UN725 LOBAR

-LEBL

-PBN/A1B1C1D1L1O1S2T1 NAV/RNVD1A1E2 DAT/1FANSP2PDC SUR/260B

REG/N754AN EET/JOBO0045 060W0120 050W0211 LPPO0301 030W0349 020W0437 LECM0513 STG0538 LECB0624 SEL/BKJM

ACARS transmission of ADS-C downlink

QU NYCODYA

.DDLXCXA 010006

PAR

FI AA66/AN N754AN

DT DDL XXW 010006 F51A

-

ADS.N754AN071E3FF6D396898586589D0D1E
93EEE38E4985834F1F49FF1C71C985800E1B
310EFFFC0F1831993FFC106AB4BE2283A6

ATOP Decoded ADS-C downlink

•Jun 1 2017 12:06:46:000AM|Jun 1 2017 12:06:52:520AM|AAL66|N754AN|-2|BAS:

- Pos = 423219N0524825W
- Alt = 39000 ft
- Time = 00:06:46
- Multiple NAV units
- Accuracy < 0.25 NM
- TCAS is ON

•PRR:

- Pos = 430000N0500000W
- Alt = 39000 ft
- ETA = 00:20:53 UTC
- Pos = 440000N0400000W
- Alt = 39000 ft

•ERF:

- Track = 76.5 degree
- GS = 541.5 knots
- VR = -16 ft/min

•ARF:

- Heading = 68.0 degree
- Speed = 0.82 mach
- VR = -16 ft/min

•MET:

- Wind dir = 297 degree
- Wind spd = 106.5 knots
- Temp = -59.8 C

ADS-C Data Format

PBCS Manual Doc 9869 Appendix D

KZNY, N754AN,
B772, AAL, 20170601,
XXW, PER, 42.5386,
-52.8069, 00:06:46,
00:06:53, 7, SAT

ADS-C Data Format

PBCS Manual Doc 9869 Appendix D (Labeled)

(1) KZNY,(2) N754AN,
(3) B772,(4) AAL, (5) 20170601,
(6) XXW,(7) PER, (8) 42.5386,
(9) -52.8069,(10) 00:06:46,
(11) 00:06:53,(12) 7, (13) SAT

Multiple Entries in Periodic Files

KZAK,XX602J ,B763,JAL,20111101,POR1,ADS,+23.276252746582 ,-163.848209381104 ,00:00:04,00:00:12,8 ,SAT
KZAK,XX79AN ,B772,AAL,20111101,XXC ,ADS,+36.1039924621582 ,-164.707717895508 ,00:00:06,00:00:14,8 ,SAT
KZAK,XX80UA ,B744,UAL,20111101,XXC ,ADS,+50.3846740722656 ,-138.906497955322 ,00:00:11,00:00:19,8 ,SAT
KZAK,XX7714 ,B772,KAL,20111101,XXC ,ADS,+48.9961051940918 ,-149.995307922363 ,00:00:01,00:00:28,27 ,SAT
KZAK,XX16UA ,B744,UAL,20111101,XXC ,ADS,+37.0189476013184 ,-160.008144378662 ,00:00:13,00:00:29,16 ,SAT
KZAK,XX602J ,B763,JAL,20111101,POR1,ADS,+23.316764831543 ,-163.908462524414 ,00:00:39,00:00:46,7 ,SAT
KZAK,XX602J ,B763,JAL,20111101,POR1,ADS,+23.320198059082 ,-163.913440704346 ,00:00:42,00:00:53,11 ,SAT
KZAK,XX610A ,B763,ANA,20111101,POR1,ADS,+30.9610176086426 ,-177.126045227051 ,00:00:58,00:01:16,18 ,SAT
KZAK,XX8211 ,B744,CAL,20111101,POR1,ADS,+48.9957618713379 ,-149.993076324463 ,00:01:07,00:01:27,20 ,SAT
KZAK,XXPS ,B77W,CPA,20111101,XXC ,ADS,+47.5766372680664 ,+177.395553588867 ,00:01:23,00:01:40,17 ,SAT
KZAK,XX572S ,K35R,E23,20111101,XXC ,ADS,+18.4503364562988 ,+164.46310043335 ,00:01:24,00:01:40,16 ,SAT
KZAK,XX92FD ,B77L,FDX,20111101,AME1,ADS,+50.5357360839844 ,-144.251689910889 ,00:01:40,00:01:48,8 ,SAT
KZAK,XX11UA ,B772,UAL,20111101,XXC ,ADS,+25.5686187744141 ,-150.25297164917 ,00:02:00,00:02:10,9 ,SAT
KZAK,XXUF ,B744,CPA,20111101,XXC ,ADS,+47.0012283325195 ,-179.991588592529 ,00:02:02,00:02:17,15 ,SAT
KZAK,XX605J ,B763,JAL,20111101,POR1,ADS,+25.3375625610352 ,-168.286685943604 ,00:02:14,00:02:21,7 ,SAT
KZAK,XX85HA ,B763,HAL,20111101,MKK ,ADS,+25.3097534179688 ,-155.016574859619 ,00:02:29,00:02:35,6 ,VHF
KZAK,XXUK ,B744,CPA,20111101,SFO ,ADS,+37.4970245361328 ,-127.003498077393 ,00:02:48,00:02:53,5 ,VHF
KZAK,XX85HA ,B763,HAL,20111101,MKK ,ADS,+25.323486328125 ,-155.001468658447 ,00:02:38,00:03:07,29 ,VHF
KZAK,XX7585 ,A333,KAL,20111101,XXC ,ADS,+28.8128471374512 ,+176.408843994141 ,00:02:50,00:03:08,18 ,SAT
KZAK,XX27UA ,B772,UAL,20111101,XXC ,ADS,+52.0743370056152 ,-145.250587463379 ,00:03:00,00:03:08,8 ,SAT
KZAK,XX7531 ,B772,KAL,20111101,XXC ,ADS,+37.0026397705078 ,-160.004024505615 ,00:03:14,00:03:28,14 ,SAT

ANSP Monitoring of ADS-C and CPDLC

PBCS Manual Doc 9869 Appendix D.3.1

- The collected CPDLC and ADS C data are used to monitor the time/continuity of CPDLC transactions and ADS C report delivery.
- In addition to monitoring the aggregate system performance, monitoring should also be conducted for important subsets of the data, including all observed media types, message type(s), operators, aircraft types and airframes
  - The first step of the analysis is filtering the collected data.
  - Suggested filtering allows for an effective measurement of the RCP and RSP time/continuity parameters.

Filtering During Service Outages

PBCS Manual Doc 9869 Appendix D.3.1.5.4

- Outage data* should be used for filtering the ADS-C and CPDLC data sets.
  - All ADS-C reports and CPDLC transactions occurring during outage periods reported by the CSP should be removed from the data set prior to analysis.
  - All ADS-C reports and CPDLC transactions occurring during an unreported outage detected by the ANSP should also be removed.

*Outage Data collected for the assessment of availability

Filtering CPDLC Data (1)

PBCS Manual Doc 9869 Appendix D.3.1.2

- The CPDLC data sent to a regional monitoring entity should at minimum contain all transactions that contain a WILCO response. The regional monitoring entity will filter transactions as agreed by their regional forum.
- For the purposes of monitoring at the local level, it is recommended that the CPDLC transactions initiated by the following message types should be filtered from the CPDLC data set when measuring RCP:
  - Non-intervention route messages (UM 79-UM 84, UM 91, and UM 92);
  - Contact instructions (UM 117 – UM 123); and
  - RESUME NORMAL SPEED (UM 116).

Filtering CPDLC Data (2)

PBCS Manual Doc 9869 Appendix D.3.1.2

- Filtering Rationale: 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 other CPDLC uplink messages specified above will skew the observed data because of the longer response times from the flight deck.
- Filtering will drastically reduce the monthly data set for some smaller ANSPs and make it difficult to assess ACTP for individual fleets or aircraft on a monthly basis.
  - Some ANSPs may retain UM 117 – UM 123 transactions when assessing ACTP. The ANSP should decide on a data set that provides the best performance assessment capability.

Filtering ADS-C Data

PBCS Manual Doc 9869 Appendix D.3.1.3

- If an ADS-C report is sent and the acknowledgement (ACK) from the GES is not received within a defined period of time, the aircraft system will resend the report.
  - In these cases, the ATS unit may receive the same ADS-C report two or three times.
  - This typically occurs, when the aircraft system is transitioning between VHF and SATCOM media types, but there are other conditions that result in an ATS unit receiving multiple ADS-C reports.
  - Experience indicates approximately 1.5 per cent of the total ADS-C reports are duplicates.
- Duplicate ADS-C reports should be removed from the data set prior to analysis.
  - In the case of duplicate reports, only the ADS-C report with the earliest receipt time should be kept in the data set.
- All ADS-C report delivery times that are zero or less than zero should be also filtered out.
  - These times represent cases where the ADS C basic group timestamp extracted as seconds since the most recent hour was incorrectly decoded into the HH:MM:SS format by the ATS unit's system.

Calculating ACP, ACTP, and PORT

PBCS Manual Doc 9869 Appendix D.2.1.3

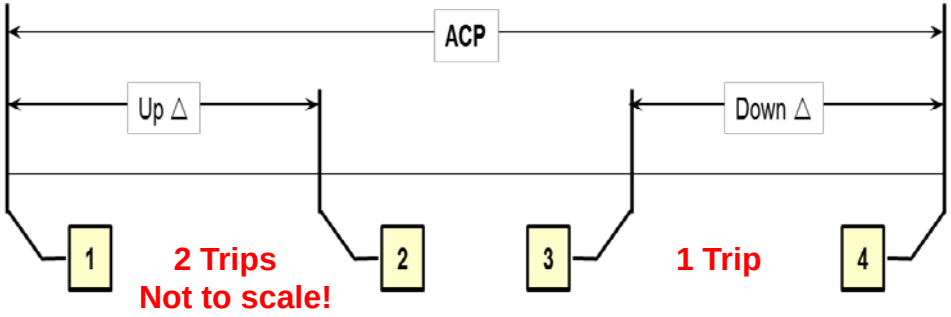
- The CPDLC analysis is based on measurement of:
  - actual communication performance (ACP) against required communication monitored performance (RCMP)
  - actual communications technical performance (ACTP) against required communication technical performance (RCTP),
  - and pilot operational response time (PORT) against RCP PORT.
- The ACP is calculated by 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
  - Figure on next slide

Calculating ACTP and PORT

PBCS Manual Doc 9869 Appendix D.2.1.3

The ACTP is **estimated** by calculating the **difference** between the **downlink**'s aircraft **time stamp and the received time** and adding it 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** response for the uplink at the ANSP

The PORT is estimated by the difference between ACP and ACTP.



1	Uplink Sent	Date/time ATSU sent CPDLC clearance to the aircraft
2	MAS Received	Date/time ATSU receives the MAS for the CPDLC clearance
3	WILCO Sent	Date/time aircraft sends WILCO response for the CPDLC clearance
4	WILCO Received	Date/time ATSU receives WILCO response for the CPDLC clearance

The measurements (in seconds) are calculated as follows:

$$ACP = (\text{WILCO Received}) - (\text{Uplink Sent}) \rightarrow \text{RCMP}$$

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

$$PORT \cong ACP - ACTP \rightarrow \text{RCP PORT}$$

Calculating ADS-C Report Delivery Time

PBCS Manual Doc 9869 Appendix D.2.2.3

- The ADS-C report delivery time is calculated by the difference between the times when the ADS-C report indicated the aircraft was at the reported position to when the ATS unit received the report.

Cumulative Distribution Analysis

PBCS Manual Doc 9869 Appendix D.3.1.5.3 Paragraph 1

- Once a sufficient sample of filtered data has been collected, the next step is to calculate a cumulative distribution for each of the performance parameters to be measured:
  - ACP, ACTP, PORT, for the CPDLC applications
  - ASP for the ADS-C application.
- It is recommended that the ANSP begins with graphical analysis of the data as this method is useful for clearly depicting the performance and facilitating the identification of performance problems.
- The cumulative performance should be shown in comparison to the relevant parameter values for the transaction times and corresponding continuity requirements
  - When measuring the cumulative ACP for an RCP 240 operation, the following parameters values should be included to determine whether or not the operation is meeting the RCP 240 safety and efficiency requirements:
    - 240 seconds at 99.9 per cent and 210 seconds at 95.0 per cent.

Cumulative Distribution Analysis

PBCS Manual Doc 9869 Appendix D.3.1.5

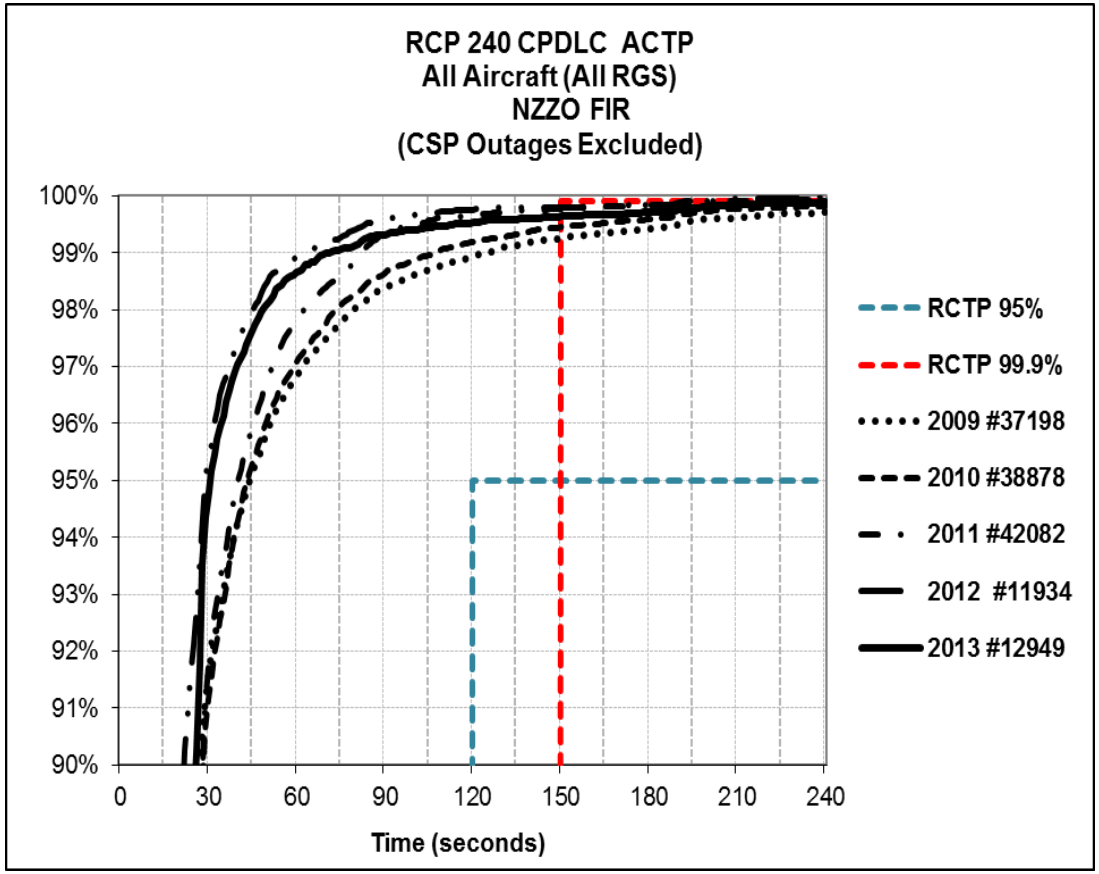
- When providing cumulative distributions of CPDLC and ADS C data, a sufficient sample size should be determined taking into account a number of factors, such as:
  - **type of data** that will be considered in the sample (e.g. CPDLC transactions that are representative of an intervention to maneuver the aircraft in the event of a conflict, or ADS-C reports);
  - **cost, time and difficulty in collecting the data** (e.g. for an entire airspace, an aircraft operator's fleet, an aircraft type/system, or a new media type);
  - **existing knowledge** about the underlying technologies and implementation (e.g. data have already been collected and analyzed from a similar implementation using similar technologies);
  - **variability** of the data collected (e.g. how predictable is it that the performance will fall within a specified range?);
  - **the specific criterion** that the data sample will be measures against (e.g. if the criterion is specified at 95 per cent, then, statistically, the data sample would need to be at least 1 000 data points); and
  - **level of confidence** desired in the estimated result (e.g. operational judgment will play a role).

Cumulative Distribution Analysis Sample

PBCS Manual Doc 9869 Appendix Figure D-3

Typical graph illustrating ACTP over SATCOM in the NZZO FIR between 2009 and 2013

- The performance is measured against the RCP 240 specifications defined for ACTP, 95 per cent within 120 seconds and 99.9 per cent within 150 seconds.



Tabular Performance Sample

PBCS Manual Doc 9869 Appendix Table D-6

Tabular format is useful when there is an impractical amount of series associated with a particular subset to be clearly displayed on a chart

This table illustrates a tabular performance report for ASP, ACP, ACTP, and PORT ACTP by operator

Oper	ADS-C				CPDLC						
Code	Count of ADS-C	% of Total ADS-C	ASP 95%	ASP 99.9%	Count of CPDLC	% of Total CPDLC	ACTP 95%	ACTP 99.9%	ACP 95%	ACP 99.9%	PORT 95%
R	141 591	12.3%	98.2%	99.4%	2 712	7.0%	99.3%	99.4%	98.5%	98.8%	95.9%
AA	113 648	9.9%	99.2%	99.8%	5 309	13.7%	99.9%	99.9%	99.5%	99.6%	97.9%
L	85 874	7.5%	98.0%	99.3%	2 490	6.4%	99.4%	99.6%	98.6%	98.8%	95.0%
BB	62 638	5.5%	99.2%	99.5%	3 096	8.0%	99.5%	99.6%	99.3%	99.7%	97.4%
II	58 775	5.1%	99.5%	99.8%	1 875	4.8%	100.0%	100.0%	99.2%	99.5%	96.6%
A	54 411	4.7%	96.0%	98.5%	1 133	2.9%	98.3%	98.9%	97.6%	98.2%	95.3%
FF	51 564	4.5%	97.5%	99.4%	2 711	7.0%	99.6%	99.7%	99.2%	99.5%	97.2%
GG	42 737	3.7%	99.2%	99.7%	1 185	3.1%	99.7%	99.8%	99.2%	99.4%	95.5%
HH	42 369	3.7%	99.4%	99.7%	1 393	3.6%	99.7%	99.9%	99.2%	99.5%	93.2%
DD	40 236	3.5%	96.5%	99.1%	2 051	5.3%	99.6%	100.0%	98.6%	99.1%	94.0%
SS	31 387	2.7%	98.2%	99.6%	524	1.3%	99.1%	99.6%	98.3%	99.1%	92.6%
BH	30 213	2.6%	94.3%	97.4%	939	2.4%	98.1%	98.8%	96.5%	97.8%	92.3%
EE	28 790	2.5%	99.2%	99.6%	1 856	4.8%	99.7%	99.7%	99.0%	99.4%	94.9%
CC	24 260	2.1%	98.5%	99.2%	856	2.2%	99.7%	99.8%	99.3%	99.5%	96.9%
TT	23 432	2.0%	99.7%	99.9%	777	2.0%	99.7%	99.7%	99.4%	99.6%	96.7%
JJ	23 352	2.0%	98.9%	99.8%	338	0.9%	99.7%	99.7%	98.2%	98.5%	94.1%
KKKK	21 066	1.8%	99.7%	99.8%	1 657	4.3%	100.0%	100.0%	100.0%	100.0%	98.1%
MM	20 228	1.8%	99.5%	99.8%	553	1.4%	99.8%	99.8%	98.9%	99.1%	95.8%
AQ	18 239	1.6%	96.8%	98.5%	733	1.9%	98.8%	99.5%	98.1%	99.2%	93.7%
PP	15 648	1.4%	99.1%	99.9%	429	1.1%	100.0%	100.0%	100.0%	100.0%	96.7%
MMMM	15 027	1.3%	96.2%	98.2%	336	0.9%	99.1%	99.1%	95.8%	97.6%	86.6%
ZZ	14 595	1.3%	99.2%	99.7%	599	1.5%	99.8%	99.8%	99.3%	99.8%	98.2%
Meets criteria →				Under criteria but above 99.0% →					Under criteria →		

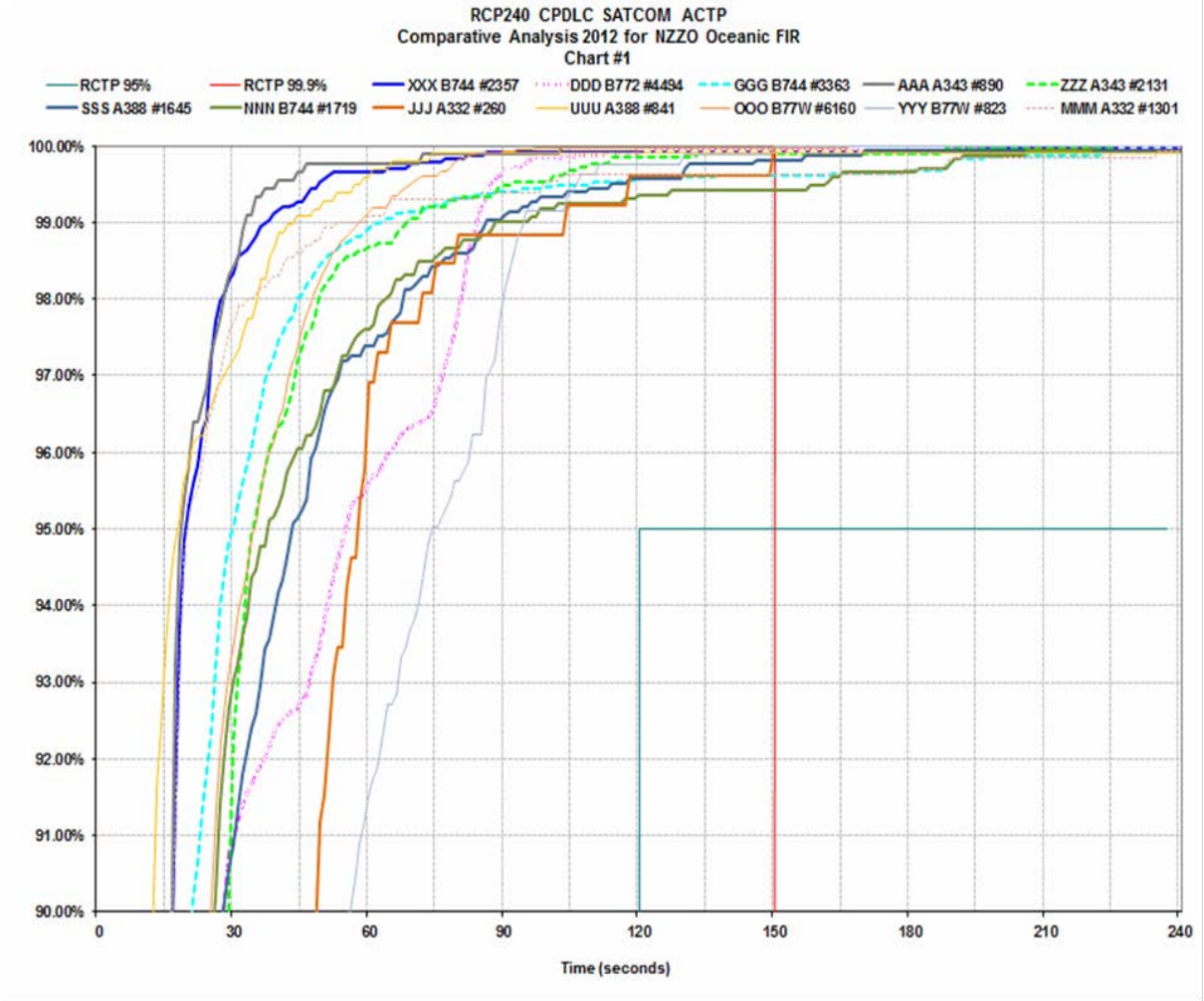
Cumulative Distribution Analysis Sample

PBCS Manual Doc 9869 Appendix Figure D-5

Comparative analysis of the ACTP over SATCOM for different fleets operating in NZZO FIR during 2012.

Significant variations in observed performance, especially for the same aircraft type should be flagged for further analysis.

It may also be useful to compare the performance of underperforming fleets with that observed for the same fleet in other CTAs.



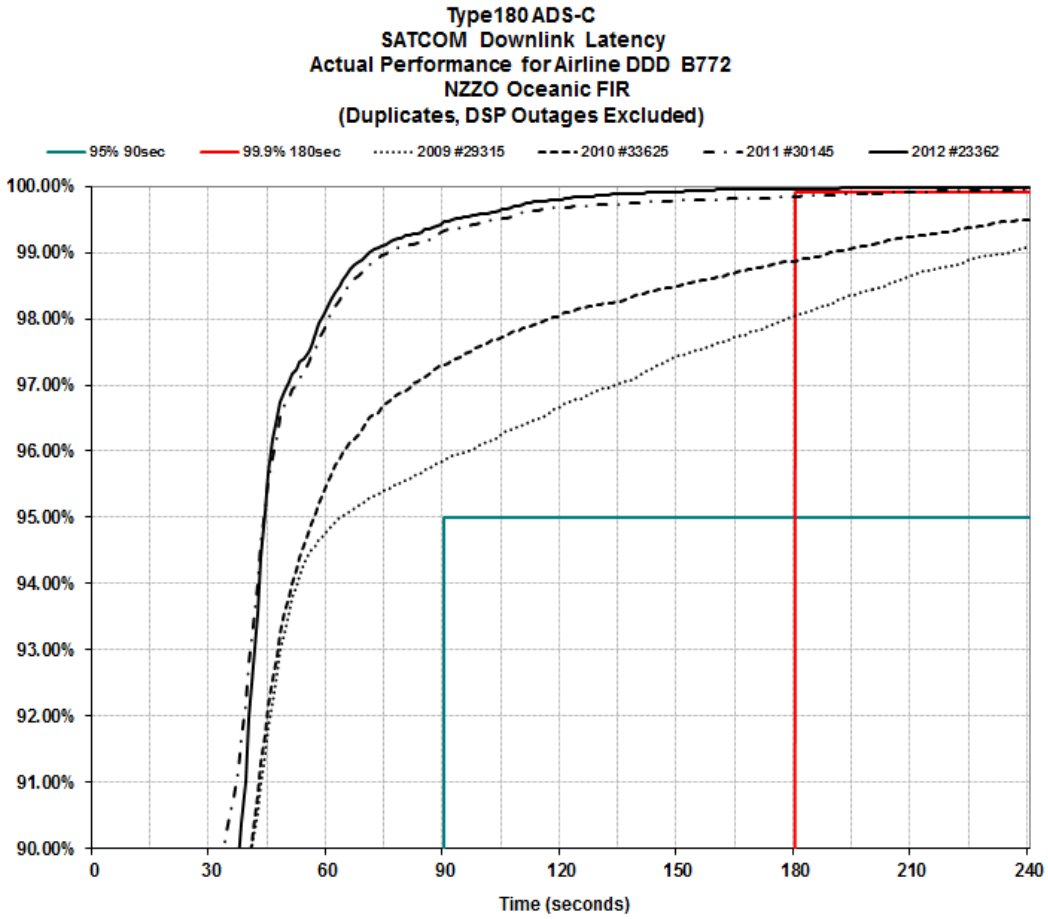
Cumulative Distribution Analysis Sample

PBCS Manual Doc 9869 Appendix Figure D-6

Performance before and after an issue was identified with the B772 fleet of operator DDD in 2009.

The regional CRA determined the poor performance of this fleet to be related to an aircraft issue that affected all B777 aircraft,

- Eventually resolved by a software upgrade.
- It should be noted that software upgrades for aircraft may take some time to be implemented by all airlines.



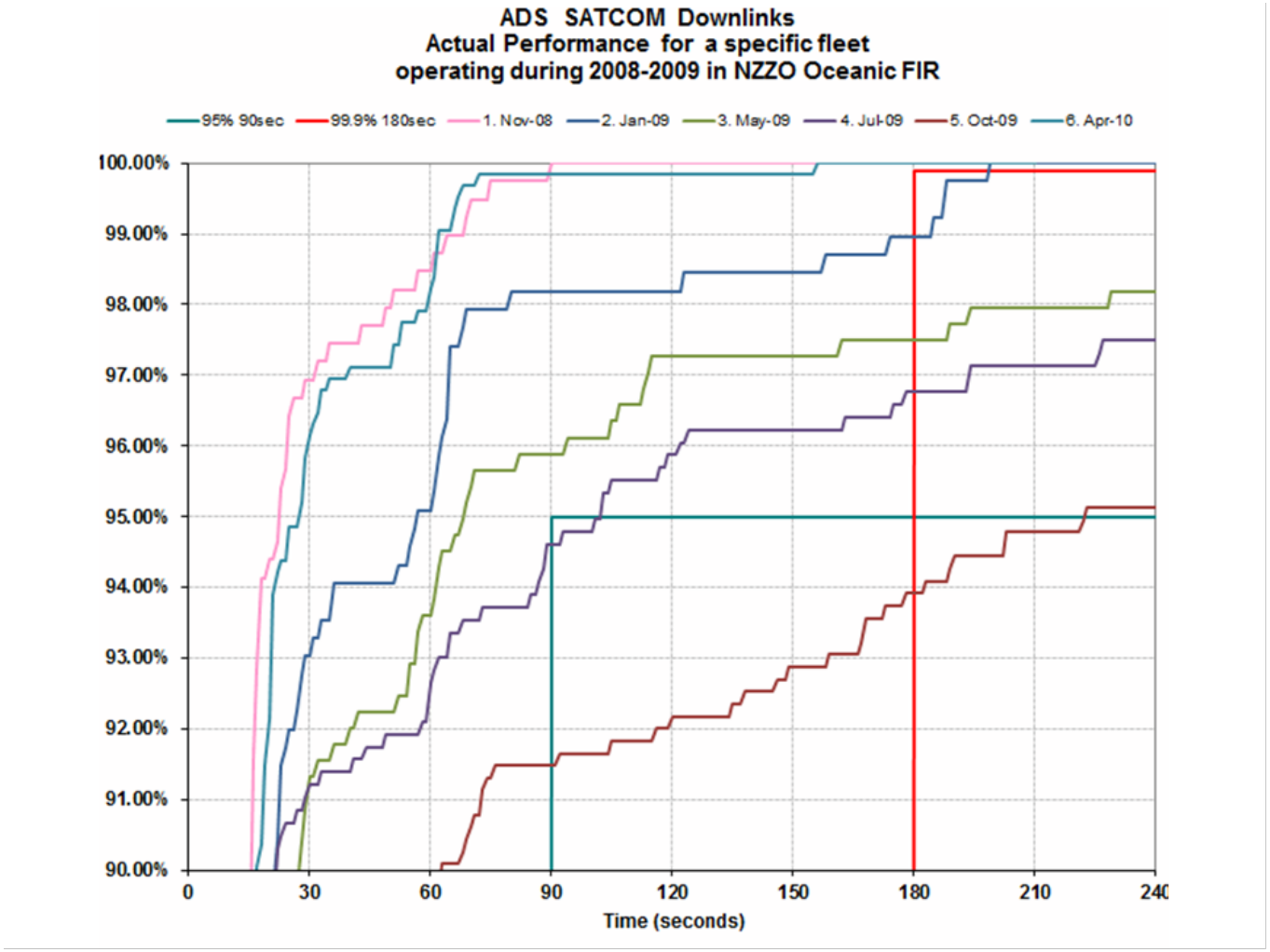
Case Study

PBCS D.3.4

- In early 2009, a slight performance degradation was detected for both CPDLC and ADS C through an analysis of the December 2008 performance data from NZZO, as measured against the RCP 240/RSP 180 specifications.
  - 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 RSP 180 performance standard is illustrated in Figure D-11 and CPDLC performance as measured against the RCP 240 specification is illustrated in Figure D-12.

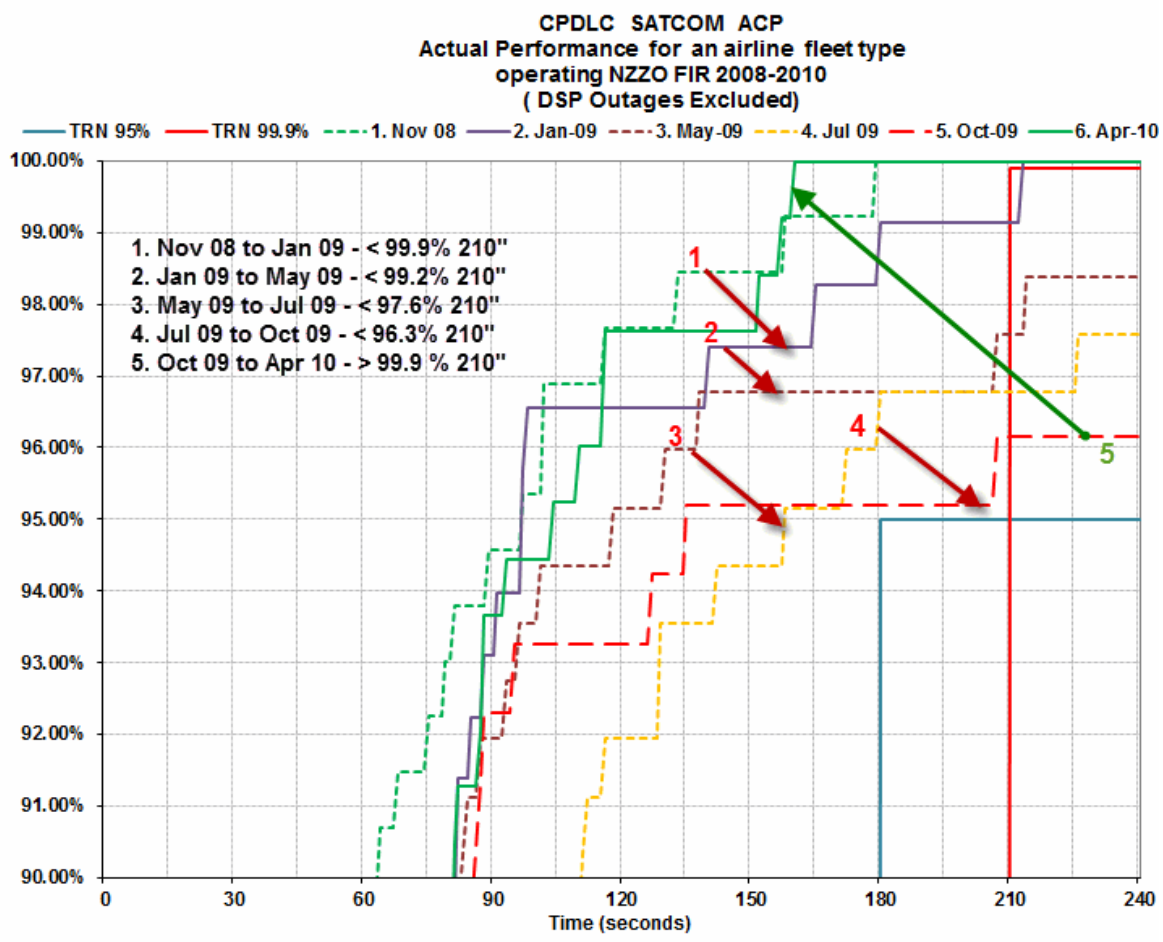
Case Study: ADS-C Performance

PBCS Manual Doc 9869 Appendix Figure D-11



Case Study: CPDLC Performance

PBCS Manual Doc 9869 Appendix Figure D-12



Case Study : Findings

PBCS D.3.4

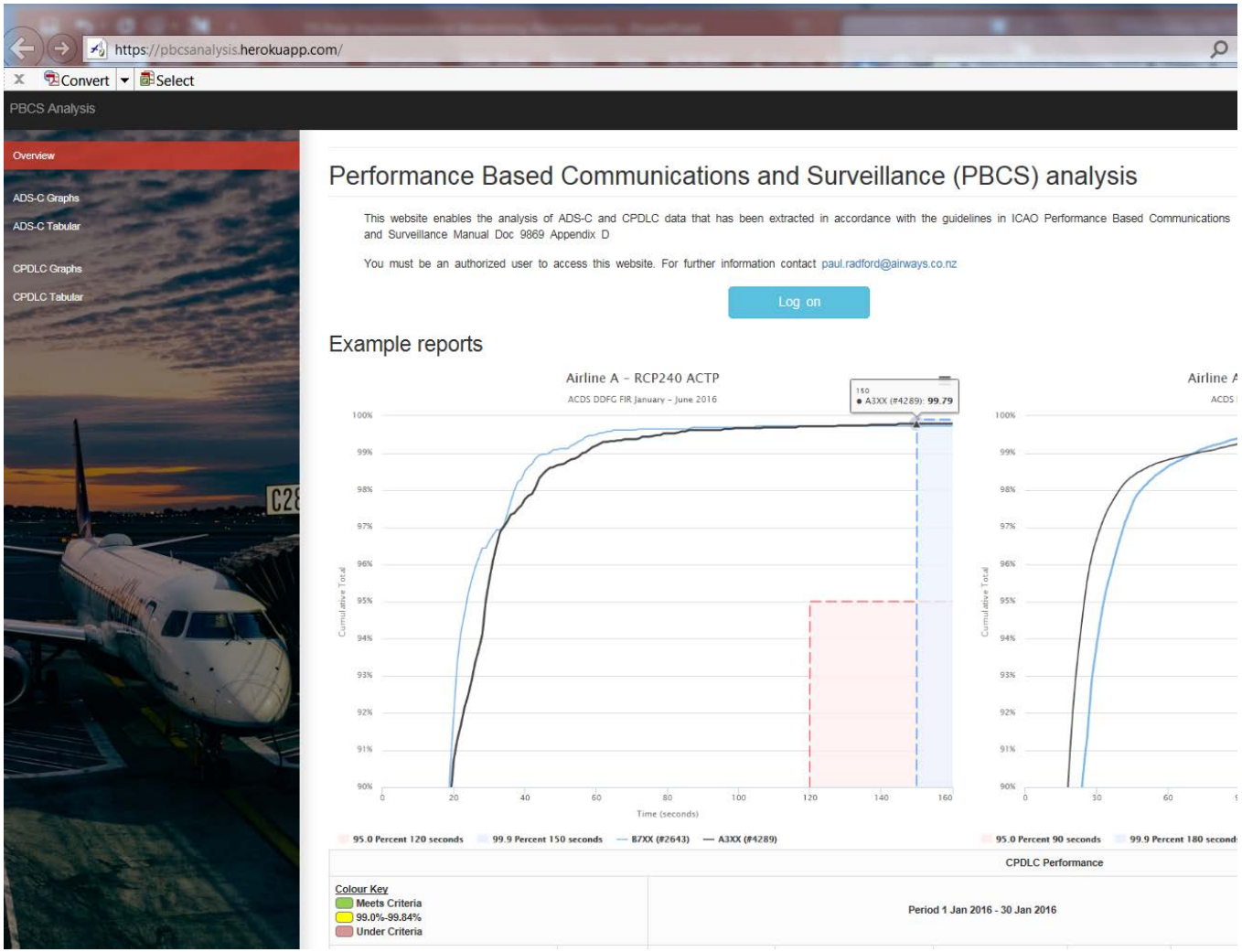
- A safety assessment in early 2009 concluded that reduced separation standards dependent on RCP/RSP specifications would be withdrawn although CPDLC and ADS-C would continue to be used.
- The cause of the problem was identified in mid-2009 as a system level GES issue. This was caused by the implementation 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 RSP 180/RCP 240 standard.
- Reduced separation standards were restored to the fleet in April 2009 after monitoring had demonstrated that performance standard compliance had been achieved.

Regional Performance Monitoring

PBCS Manual Doc 9869 Appendix D.4.1

- Periodic reporting by each ANSP of observed system performance in its respective airspace will enable regional performance metrics to be developed for the availability, CPDLC transaction time and ADS-C surveillance data transit time requirements specified in the PBCS Manual
- 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
  - https://pbcsanalysis.herokuapp.com/
- 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.

Regional Performance Data Site Example



Monitoring Reports for Region/Global Use

PBCS Manual Doc 9869 Appendix D.3.3

- Each ANSP within a region should compile monitoring reports at the interval agreed by the regional forum.
- A tabular format can be used to report on the observed system performance in terms of the availability and time/continuity parameters specified in the applicable RCP and RSP specifications.
  - Examples to follow

Monitoring Report Sample

PBCS Manual Doc 9869
Appendix Table D-8

Example RCP PBCS Monitoring Report

PBCS Monitoring Report – RCP							
ANSP/CTA →	ANSP1/CTA1		**Period →**		1 Jan to 30 Jun 2014 (6 months)		
Specification →	RCP 240		**Application →**		CPDLC		
Colour Key		**Transaction Counts (WILCO Received)**	**95% RCP 240 benchmark**		**99.9% RCP 240 benchmark**		
Meets criteria →			**ACP**	**ACTP**	**ACP**	**ACTP**	**PORT**
Under criteria but above 99.0% →			**<=180 sec**	**<=120 sec**	**<=210 sec**	**<=150 sec**	**<=60 sec**
Under criteria →			**End-to-End**	**Network**	**End-to-end**	**Network**	**Pilot Response**
Media Type (100 messages or more)							
SATCOM		35 123	98.90%	99.53%	99.28%	99.67%	
VHF		3 422	99.15%	99.80%	99.27%	99.85%	
HF		13					
SATCOM+HF		-					
SAT+VHF		-					
VHF+SAT		-					
HF+VHF		-					
. . .							
All		38 837	98.86%	99.52%	99.23%	99.67%	
Remote Ground Station (RGS) / Ground Earth Station (GES) (100 messages or more)							
GES1	VHF	14 476	99.03%	99.68%	99.32%	99.76%	
GES2	VHF	5 893	99.42%	99.69%	99.69%	99.76%	
GES3	VHF	4 494	98.49%	99.29%	98.82%	99.49%	
GES4	VHF	4 328	99.26%	99.70%	99.54%	99.77%	
GES5	VHF	1 455	95.60%	97.73%	97.32%	98.63%	
. . .							
Uplink Message Type (UM) (100 messages or more)							
U20 U129		13 516	99.29%	99.64%	99.59%	99.74%	97.57%
U26 U129		12 894	99.12%	99.54%	99.37%	99.64%	96.49%
U106		2 301	99.48%	99.70%	99.70%	99.74%	98.44%
U74		1 001	97.60%	99.30%	98.50%	99.60%	92.01%

Monitoring Report Sample

PBCS Manual Doc 9869
Appendix Table D-9

Example RSP PBCS Monitoring Report

PBCS Monitoring Report – RSP			
ANSP/CTA →	ANSP1/CTA1	**Period →**	1 Jan to 30 Jun 2014 (6 months)
Specification →	RSP 180	**Application →**	ADS-C

Colour Key		**Report Counts**	**95% RSP 180 benchmark**	**99.9% RSP 180 benchmark**
Meets criteria →			**ASP**	**ASP**
Under criteria but above 99.0% →			**<=90 sec**	**<=180 sec**
Under criteria →			**End-to-End**	**End-to-end**
Media Type (100 messages or more)				
SATCOM		893 064	97.98%	99.27%
VHF		251 619	98.98%	99.54%
HF		4 013	92.30%	94.49%
. . .				
All		1 148 696	98.09%	99.28%
Remote Ground Station (RGS) / Ground Earth Station (GES) (100 messages or more)				
GES1	VHF	355 121	98.57%	99.51%
GES2	VHF	167 491	97.54%	99.31%
GES3	VHF	106 908	99.05%	99.62%
GES4	VHF	101 662	98.64%	99.38%
GES5	VHF	38 006	91.96%	96.33%
. . .				
Operator (100 messages or more)				
OP1		141 591	98.17%	99.35%
OP2		113 648	99.17%	99.78%
OP3		85 874	98.01%	99.31%
OP4		62 638	99.23%	99.46%
OP5		30 213	94.31%	97.44%
. . .				

Regional CPDLC Reporting

PBCS Manual Doc 9869 Appendix D.4.2

- The ANSP should report observed ACP and ACTP for RCP 240 and RCP 400 for different media paths :
  - From all aircraft via all remote ground station (RGS) types.
  - From all aircraft where both uplink and downlink are via SATCOM RGS.
  - From all aircraft where both uplink and downlink are via VHF RGS.
  - From all aircraft where both uplink and downlink are via HF RGS.
  - 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 per cent and 99.9 per cent RCP 240/400 times.
- As PORT is independent of media path, this is only reported for all RGS types. An example form is shown in Table D-10.

Regional Monitoring Report Sample

PBCS Manual Doc 9869 Appendix Table D-11

Consistent data provided by each of the ANSPs within a region can be aggregated to create a regional PBCS monitoring report in graphical or tabular form.

Regional PBCS Monitoring Report						
Region →	LAT Region		**Period →**	1 Jan to 30 Jun 2014 (6 months)		
RCP						
Specification →	RCP 240		**Application →**	CPDLC		
Colour Key		**Transaction Counts (WILCO Received)**	**95% RCP 240 benchmark**		**99.9% RCP 240 benchmark**	
Meets criteria →			**ACP**	**ACTP**	**ACP**	**ACTP**
Under criteria but above 99.0% →			**<=180 sec**	**<=120 sec**	**<=210 sec**	**<=150 sec**
Under criteria →			**End-to-End**	**Network**	**End-to-end**	**Network**
ANSP/Control area (CTA)						
LAT Region		201 723	98.6%	99.0%	99.4%	99.6%
ANSP1/CTA1		27 608	98.5%	98.9%	99.3%	99.6%
ANSP2/CTA2		22 736	98.9%	99.3%	99.5%	99.6%
. . .						
RSP						
Specification →	RSP 180		**Application →**	ADS-C		
Colour Key (Same as for RCP)		**Report Counts**	**95% RSP 180 benchmark**		**99.9% RSP 180 benchmark**	
			ASP % <=90 sec		**ASP % <=180 sec**	
Control area						
LAT Region		5 043 218	98.4%		99.4%	
ANSP1/CTA1		484 610	97.7%		98.9%	
ANSP2/CTA2		628 998	98.6%		99.3%	
. . .						

Regional RSP Reporting

PBCS Manual Doc 9869 Appendix D.4.3

- The ANSP should report observed RSP data transit time for RSP 180 and RSP 400 and DO290/ED120 based performance specifications for different media paths :
  - From all aircraft via all Remote Ground Station (RGS) types.
  - From all aircraft where both uplink and downlink are via SATCOM RGS.
  - From all aircraft where both uplink and downlink are via VHF RGS.
  - From all aircraft where both uplink and downlink are via HF RGS.
  - From all aircraft where either uplink and downlink are via HF or SATCOM RGS.

Summary

- Detailed review of sections of the data collection and analysis sections of PBCS 9869 Appendix D
  - Availability analysis
  - CPDLC data collection and example decode
  - ADS-C data collection and example decode
  - Filtering data
  - Calculating monitoring parameters
- Reviewed the analysis examples in the appendix
- Reviewed the details on example regional reporting charts