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Agenda Item 4: Review of ADS/CPDLC Operations and Performance

DATA LINK PERFORMANCE REPORT FOR AIRWAYS NEW ZEALAND

(Presented by Airways New Zealand)

SUMMARY

This paper presents data link performance data for 2021 for the Auckland Oceanic FIR (NZZO), and information on actions taken to identify and rectify the causes of performance issues

1. INTRODUCTION

1.1 **Tables 1 to 3** summarize Automatic Dependent Surveillance – Contract (ADS-C) and Controller-Pilot Data Link Communications (CPDLC) performance where the Required Surveillance Performance (RSP) and Required Communications Performance (RCP) criteria stipulated in ICAO Doc 4444 – Procedures for Air Navigation Services – Air Traffic Management (PANS-ATM) were not met. Actions taken to address performance not meeting the criteria are discussed, together with the outcomes of such actions.

1.2 PBCS analysis and investigation can be resource intensive. Airways New Zealand uses an on-line tool to facilitate analysis. This tool allows the import of CPDLC and ADS-C data in GOLD format and the manipulation of the data to provide tabular and graphical performance results for selected data sets. The tool also extracts the consolidated CPDLC and ADS-C performance results for use in our monthly analysis of PBCS performance for the New Zealand CAA, the six monthly PBCS performance data listed on the CRA website, and our annual FIT-Asia and ISPACG reports. A recent upgrade to the tool allows for the creation of Google Earth files that display selected data points. Airways has found that the geographical display of delayed data points is useful in identifying performance issues. This upgrade is described in **paragraph 2.15**.

2. DISCUSSION

NZZO FIR ADS-C RSP180 Performance – Media Type, RGS and GES

2.1 **Table 1** summarizes overall ADS-C performance per media type, Remote Ground Station (RGS) and Ground Earth Station (GES) for downlinks sent within the NZZO FIR during 2021, where performance did not meet the RSP180 performance criteria.




FIR		NZZO					
Criteria		RSP180					
Period		Jan-June 2021			July-December 2021		
Colour Key  Meets Criteria  99.0%-99.84%  Under Criteria	Message Counts	95%	99.90%	Message Counts	95%	99.90%	
		% <= 90sec	% <= 180sec		% <= 90sec	% <= 180sec	
By Media Type							
SATCOM		121659	98.86	99.76	114031	98.98	99.82
VHF		29708	99.83	99.96	31611	99.77	99.94
HF		71	74.64	90.14	83	57.83	74.69
ALL		151438	99.04	99.8	145725	99.13	99.83
By Remote Ground Station (RGS) Ground Earth Station (GES)							
Designator	Type	(Only RGS/GES with message counts >100 recorded)					
AME2	SAT	122	91.8	99.18	535	98.31	99.81
IG1	SAT	728	93.54	98.48	487	94.25	98.35

Table 1: NZZO FIR ADS-C Downlink Latency per Media Type, RGS and GES

2.2 The use of HF datalink in NZZO is low with few aircraft now using the media. The HF DL performance illustrated is typical. Aircraft are generally using HF DL in a “next on busy” mode with satcom. The occasional flight will dispatch without satcom using HF DL as primary means. We filter these flights when assessing RCP240/RSP180 performance, because HF DL when used as primary means does not meet PBCS RCP240/RSP180 requirements, and the aircraft should not be filing PBCS status in this mode of operation.

2.3 NZZO is on the southern boundary of AME2 coverage, and the AME2 RGS makes up just 0.3% of our satcom data. An analysis of the aircraft using AME2 in 2021 and the excellent performance from the THT B789 fleet indicates that the observed AME2 performance is an aircraft rather than a RGS issue. Please refer to **paragraphs 2.9 and 2.10** below for analysis of the FJI A332 and A333 performance.

ADS-C Performance								
Colour Key		Period 1 Jan 2021 - 31 Dec 2021					95% RSP180 Benchmark	99.9% RSP180 Benchmark
Media Type	RGS	Aircraft Type	Operating Company	Tail Number	ATSP	Message Count	RSP <= 90 sec	RSP <= 180 sec
Analysis by								
SATCOM All	AME2	B789	ANZ	All	NZZO	20	100	100
SATCOM All	AME2	A332	CTM	All	NZZO	9	100	100
SATCOM All	AME2	A332	FJI	All	NZZO	65	89.23	96.92
SATCOM All	AME2	A333	FJI	All	NZZO	62	85.48	100
SATCOM All	AME2	A343	HFM	All	NZZO	6	100	100
SATCOM All	AME2	B789	LAN	All	NZZO	26	100	100
SATCOM All	AME2	GLEX	LXJ	All	NZZO	34	100	100
SATCOM All	AME2	B789	THT	All	NZZO	435	99.31	100

2.4 We see low Iridium IG1 use in NZZO and it is 1% of our satcom data. An analysis of the aircraft using IG1 below and the excellent performance from the GTI B744 and OAE B762 fleet indicates that the observed performance from the IG1 RGS is an aircraft rather than an RGS issue.

ADS-C Performance								
Colour Key		Period 1 Jan 2021 - 31 Dec 2021					95% RSP180 Benchmark	99.9% RSP180 Benchmark
Media Type	RGS	Aircraft Type	Operating Company	Tail Number	ATSP	Message Count	RSP <= 90 sec	RSP <= 180 sec
Analysis by								
SATCOM All	IG1	B748	CPA	All	NZZO	19	63.15	89.47
SATCOM All	IG1	B77W	CPA	All	NZZO	363	89.8	97.52
SATCOM All	IG1	GL7T	CPJ	All	NZZO	41	95.12	97.56
SATCOM All	IG1	B737	EDG	All	NZZO	12	100	100
SATCOM All	IG1	CL60	FLC	All	NZZO	6	100	100
SATCOM All	IG1	B744	GTI	All	NZZO	306	98.69	99.67
SATCOM All	IG1	FA8X	LUC	All	NZZO	13	100	100
SATCOM All	IG1	B762	OAE	All	NZZO	109	99.08	100
SATCOM All	IG1	B744	PAC	All	NZZO	33	100	100
SATCOM All	IG1	A21N	PAL	All	NZZO	265	91.69	98.11
SATCOM All	IG1	E35L	PVT	All	NZZO	15	100	100
SATCOM All	IG1	GLF4	PVT	All	NZZO	33	93.93	96.96

2.5 For the three fleets above with more than 100 data points: the GTI B744 fleet is meeting RSP180 requirements in the 2021 year; please refer to **paragraph 2.11** below for an analysis of the PAL A21N fleet; and the CPA B77W fleet operates through both Iridium and Inmarsat satcom on the fleet which complicates analysis. The PBCS certified CPA B77W Inmarsat equipped aircraft meet PBCS requirements. CPA stopped filing PBCS FPL equipage on their B77W Iridium equipped aircraft in 2020 while they resolved a reported performance issue with this fleet. The comparative performance observed in 2021 between the Iridium and Inmarsat fleets is illustrated below.

ADS-C Performance									
Colour Key		Period 1 Jan 2021 - 31 Dec 2021					95% RSP180 Benchmark	99.9% RSP180 Benchmark	
Meets Criteria	99.0%-99.84%	Under Criteria							
Media Type	RGS	Aircraft Type	Operating Company	Tail Number	ATSP	Message Count	RSP <= 90 sec	RSP <= 180 sec	
Analysis by									
All	IG1	B77W	CPA	All	NZZO	363	89.8	97.52	
All	XXA	B77W	CPA	All	NZZO	369	96.74	99.72	
All	XXP	B77W	CPA	All	NZZO	369	98.37	100	

NZZO FIR ADS-C RSP180 Performance – Aircraft Operator/Type

2.6 **Table 2** summarizes overall ADS-C performance per Aircraft Operator/Type for downlinks sent within the NZZO FIR during 2021, where performance did not meet the RSP180 performance criteria.

FIR	NZZO					
Criteria	RSP180					
Period	Jan-June 2021			July-December 2021		
Colour Key Meets Criteria 99.0%-99.84% Under Criteria	Message Counts	95%	99.90%	Message Counts	95%	99.90%
		% <= 90sec	% <= 180sec		% <= 90sec	% <= 180sec
By Aircraft Operator / Type (Only message counts >100 recorded)						
ANZ/A20N	7677	96.72	98.93	2126	98.17	99.62
CSN/A333	195	98.97	98.97	-	-	-
FJI/A332	1211	95.62	98.43	1480	95.61	98.45
FJI/A333	1137	93.84	98.24	1485	94.95	99.12
PAL/A21N	154	93.51	97.40	204	94.12	99.51
TMN/B763	3238	96.94	98.98	3641	97.01	98.30

Table 2: NZZO FIR ADS-C Downlink Latency per Aircraft Operator/Type

2.7 The ANZ A20N degradation is attributed to departing flights in the vicinity of Norfolk Island. These departing flights establish multiple ADS-C contracts with YBBB, NFFF, and NZZO because of the location of Norfolk Island in NZZO which is close to the boundary of both the YBBB and NFFF FIR. For aircraft departing Norfolk Island to the North when the aircraft connects with NZZO on the ground it is automatically address forwarded to NFFF and YBBB who immediately enable ADS-C contracts. The multiple contract establishment and the handshaking required by address forwarding seems to swamp the system. The aircraft use Iridium satcom media because the Norfolk Island VHF

RGS has been withdrawn from service. We identified that with the Norfolk Island departures excluded, ANZ A20N fleet performance in the remainder of the FIR was meeting RSP180 performance requirements (99.23% <=90 sec/100.00% <=180 sec). A problem report was raised in November 2020 when the issue was first identified and was updated each month. The fleet stopped operating on YSNF sectors in March 2021. ATC were advised of the deterioration below PBCS requirements in the vicinity of YSNF and PBCS operations continued in the remainder of the NZZO FIR during the period.

2.8 The CSN A333 fleet only operated in NZZO in June and December 2021. With the small dataset available for evaluation and with the fleet meeting RSP180 95% normal operating requirements no action was taken on the deterioration observed at the 99.90% 180 second performance requirement.

2.9 The FJI A332 fleet had ongoing performance issues through 2021 with PBCS non-compliance reports filed with PARMO in January and February and the CRA problem report that was raised in 2020 updated. We worked directly with Fiji Airways technical staff and appraised them of the monthly performance results as they worked on the issue through 2021. The latency delays observed were associated with excessive switching between the AME1, AME2, APK1, and APK2 satellite RGS. This issue was resolved and the consolidated performance from the FJI A332 fleet for the period December 2021 to February 2022 is illustrated below.

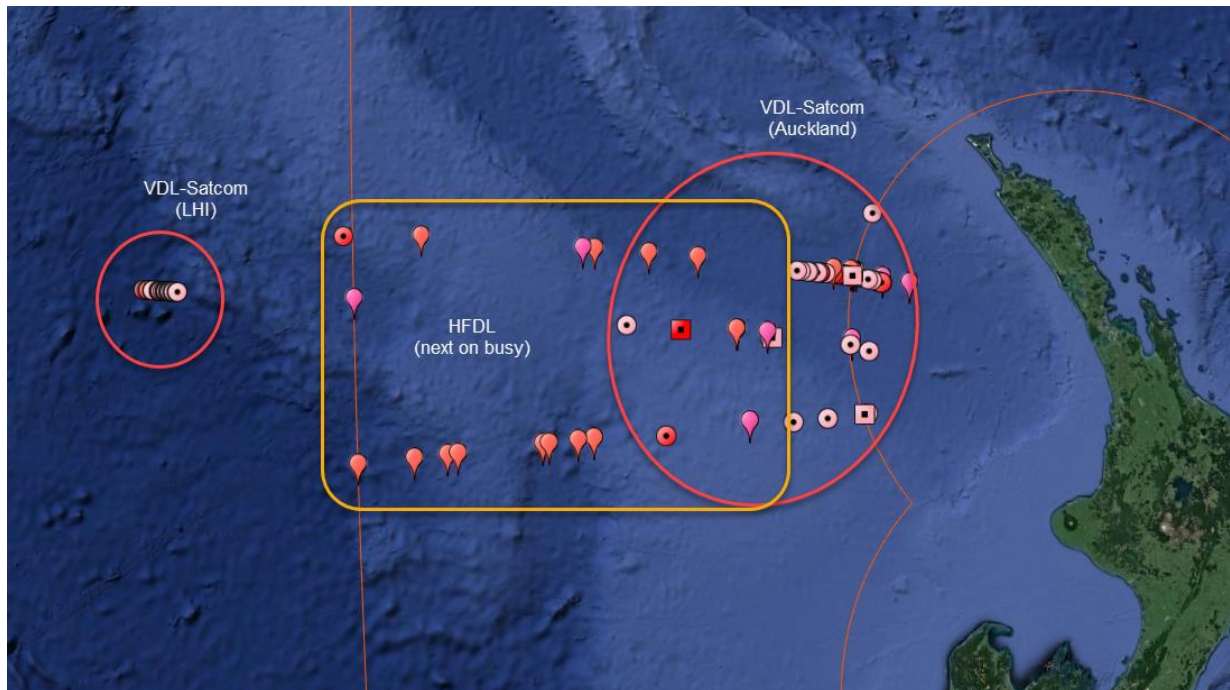
Operator	Aircraft Type	Tail No	ADS-C downlink Message counts	ASP <= 90 sec	ASP <= 180 sec	CPDLC Transaction Counts (WILCO received)	ACP <= 180 sec	ACP <= 210 sec
FJI	A332	DQFJT	342	97.95%	100.00%	5	100.00%	100.00%
FJI	A332	DQFJU	298	97.32%	100.00%	4	100.00%	100.00%
FJI	A332	DQFJV	134	99.25%	100.00%	2	100.00%	100.00%

2.10 The FJI A333 aircraft had ongoing issues through 2020 and a CRA problem report was raised and a PBCS non-compliance report filed with PARMO in 2020. Fiji Airways stopped filing PBCS status for the aircraft during 2020. While the 2021 performance is below RSP180 requirements it meets RSP400 requirements for non-PBCS data link operations. In February 2021, the aircraft performance observed for RSP400 was 99.81% at the 95% 300 second benchmark and 100% at the 99.9% 400 second benchmark.

2.11 The PAL A20N fleet operates across the Tasman Sea to New Zealand which is a short sector of one hour. With only 2-3 flights a month insufficient data points are available to indicate any non-performance issues in our monthly PBCS analysis. The monthly PBCS analysis uses the current months dataset and the dataset for the last three months in accordance with GOLD guidance. No performance evaluation was completed for this fleet because the minimum 100 data points were not available. Performance observed from the three-monthly datasets is illustrated below.

Dates	Operator	Aircraft Type	Tail No	ADS-C downlink Message counts	ASP <= 90 sec	ASP <= 180 sec	CPDLC Transaction Counts (WILCO received)	ACP <= 180 sec	ACP <= 210 sec
202011-01	PAL	A21N	RPC9935	66	95.45%	96.97%	1	100.00%	100.00%
202012-02	PAL	A21N	RPC9933	32	93.75%	100.00%	4	100.00%	100.00%
202012-02	PAL	A21N	RPC9935	66	95.45%	96.97%	1	100.00%	100.00%
202101-03	PAL	A21N	RPC9933	63	92.06%	98.41%	4	100.00%	100.00%
202101-03	PAL	A21N	RPC9935	34	91.18%	94.12%	0	-	-
202102-04	PAL	A21N	RPC9933	63	92.06%	98.41%	4	100.00%	100.00%
202103-05	PAL	A21N	RPC9933	31	90.32%	96.77%	0	-	-
202103-05	PAL	A21N	RPC9934	18	94.44%	100.00%	0	-	-
202104-06	PAL	A21N	RPC9934	18	94.44%	100.00%	0	-	-
202104-06	PAL	A21N	RPC9936	39	97.44%	97.44%	0	-	-
202105-07	PAL	A21N	RPC9934	18	94.44%	100.00%	0	-	-
202105-07	PAL	A21N	RPC9936	72	97.22%	98.61%	0	-	-
202106-08	PAL	A21N	RPC9934	36	94.44%	100.00%	1	100.00%	100.00%
202106-08	PAL	A21N	RPC9936	72	97.22%	98.61%	0	-	-
202107-09	PAL	A21N	RPC9934	36	94.44%	100.00%	1	100.00%	100.00%
202107-09	PAL	A21N	RPC9936	62	98.39%	100.00%	1	100.00%	100.00%
202108-10	PAL	A21N	RPC9934	36	94.44%	100.00%	1	100.00%	100.00%
202108-10	PAL	A21N	RPC9935	29	75.86%	96.55%	0	-	-
202108-10	PAL	A21N	RPC9936	29	100.00%	100.00%	1	100.00%	100.00%
202109-11	PAL	A21N	RPC9933	27	100.00%	100.00%	0	-	-
202109-11	PAL	A21N	RPC9935	29	75.86%	96.55%	0	-	-
202110-12	PAL	A21N	RPC9933	77	97.40%	100.00%	0	-	-
202110-12	PAL	A21N	RPC9935	29	75.86%	96.55%	0	-	-

2.12 The TMN B763 aircraft operates on the Tasman Sea routes between Australia and New Zealand. The aircraft is not PBCS certified and meets RSP400 performance requirements for non-PBCS datalink operations. The performance degradation observed is due to two reasons: first the aircraft uses HF DL in a “next on busy” mode with satcom; and second, latency delays caused by VHF Satcom transition issues when departing New Zealand airspace and in the Tasman Sea in the vicinity of Lord Howe Island. The observed delays are shown in the graphic below. Pink symbols indicate latency between 90-180 seconds, red symbols latency greater than 180 seconds. The paddle symbol illustrates HF DL, circles satcom, and squares VDL.



NZZO FIR CPDLC RCP240 Performance – Media Type, RGS and GES

2.13 **Tables 3A and 3B** summarize overall CPDLC performance per Media Type, RGS and GES for messages sent within the NZZO FIR during 2021. Only RGS or GES where performance did not meet the RCP240 performance criteria are listed.

FIR		NZZO				
Criteria		RCP240				
Period		Jan - Jun 2021				
Colour Key ■ Meets Criteria ■ 99.0%-99.84% ■ Under Criteria	Message Counts	95% benchmark		99.9% Benchmark		95%
		ACP	ACTP	ACP	ACTP	PORT
		% <= 180sec	% <= 120sec	% <= 210sec	% <= 150sec	% < 60secs
By Media Type						
SATCOM	3073	99.73	99.90	99.86	99.93	99.25
VHF	349	100.00	100.00	100.00	100.00	100.00
HF	9	100.00	88.88	100.00	88.88	100.00
ALL	3431	99.76	99.88	99.88	99.91	99.32
By Remote Ground Station (RGS) Ground Earth Station (GES)						
Designator	Type	(RGS/GES with message counts >100)				
All RGS/GES with message counts >100 meet RCP240 requirements						

Table 3A: NZZO FIR CPDLC Performance Latency per Media Type, RGS and GES – Jan-Jun 2021.

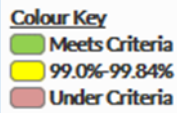
FIR		NZZO				
Criteria		RCP240				
Period		Jul - Dec 2021				
Colour Key  Meets Criteria 99.0%-99.84% Under Criteria	Message Counts	95% Benchmark		99.9% Benchmark		95%
		ACP	ACTP	ACP	ACTP	PORT
		% < =180sec	% < = 120sec	% < = 210sec	% < = 150sec	% < 60secs
By Media Type						
SATCOM	2752	99.78	99.89	99.92	99.92	99.41
VHF	463	100.00	100.00	100.00	100.00	99.78
HF	7	85.71	85.71	85.71	100.00	85.71
ALL	3222	99.78	99.87	99.90	99.93	99.44
By Remote Ground Station (RGS) Ground Earth Station (GES)						
Designator	Type	(RGS/GES with message counts >100)				
All RGS/GES with message counts >100 meet RCP240 requirements						

Table 3B: NZZO FIR CPDLC Performance Latency per Media Type, RGS and GES – Jul-Dec 2021.

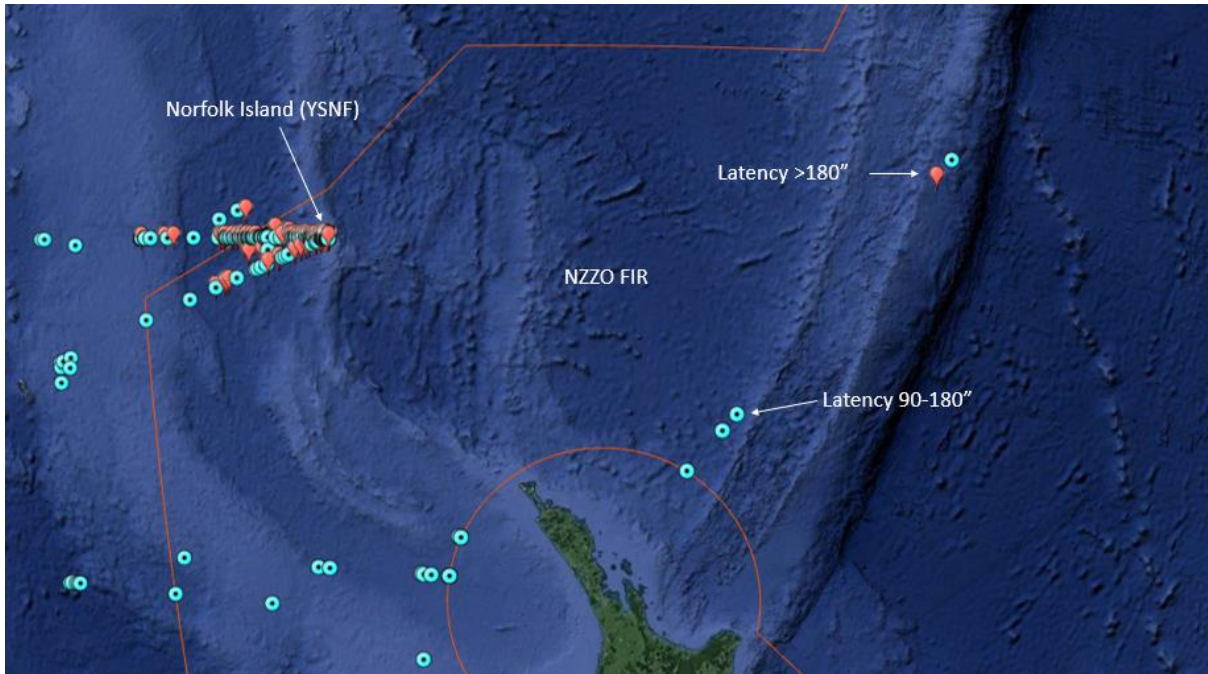
NZZO FIR CPDLC RCP240 Performance – Aircraft Operator/Type

2.14 CPDLC performance per Aircraft Operator/Type with message counts greater than 100 within the NZZO FIR during 2021 all meet the RCP240 performance criteria.

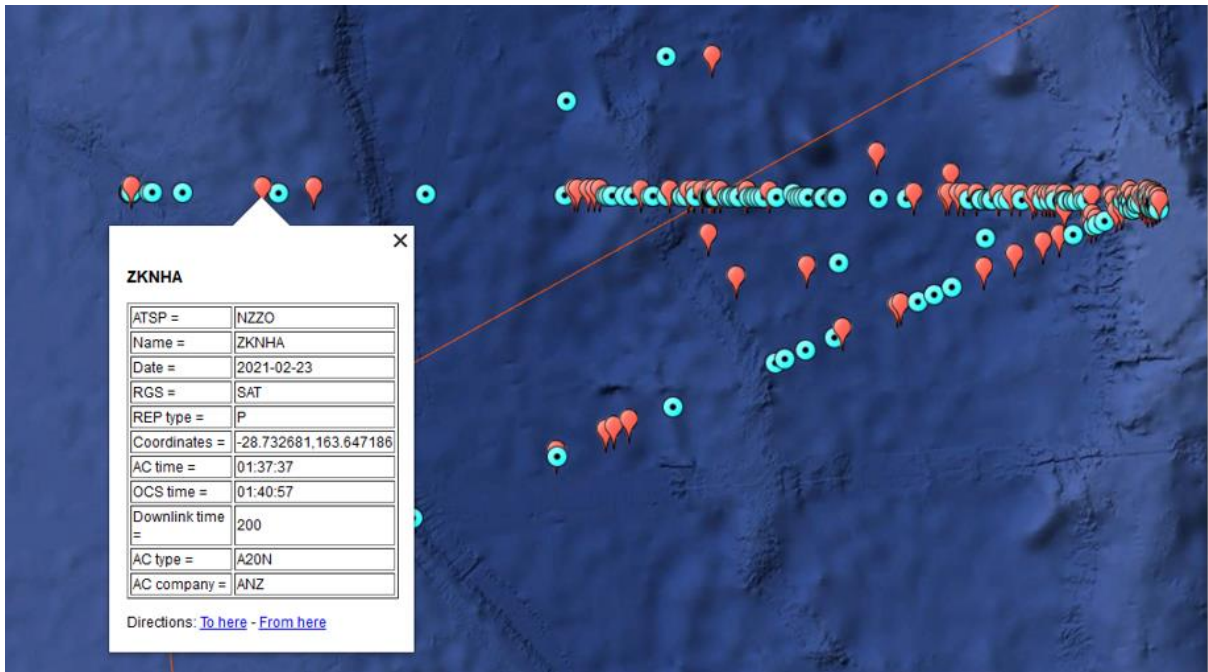
Additional Information

2.15 Airways finds that the ability to display the latency observed with each ADS-C data point on Google Earth is useful when investigating performance problems. A recent development with our online PBCS analysis tool enables the creation of Google Earth formatted files that display selected ADS-C data points from our on-line database or from imported .csv files.

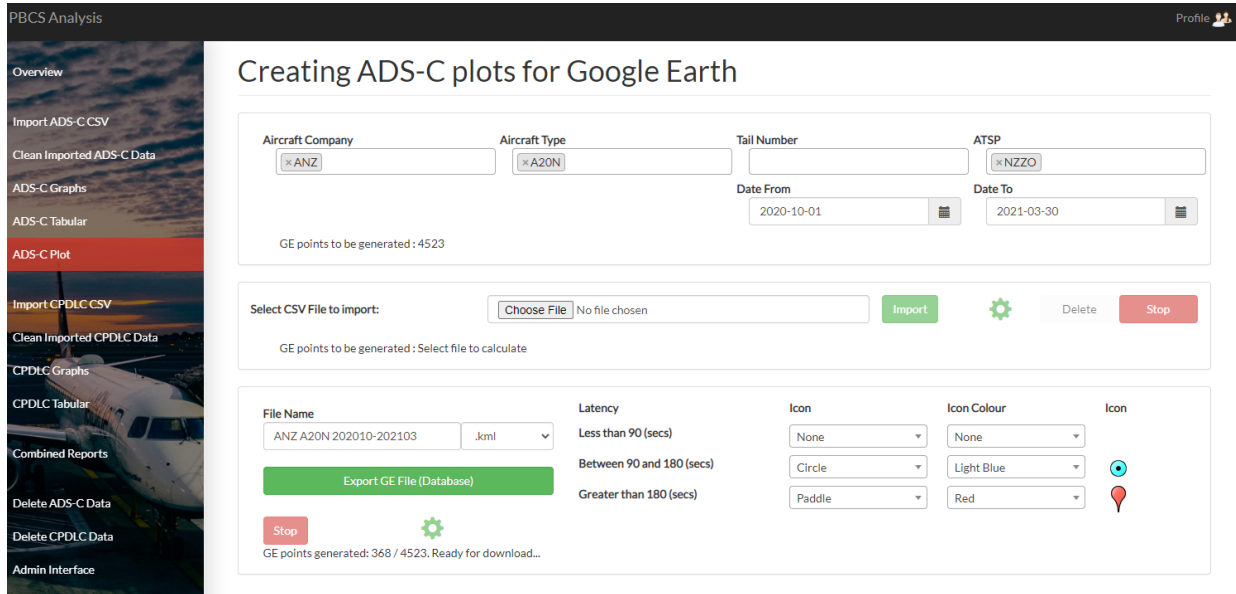
2.16 An example of a Google Earth display helping identify a performance problem is illustrated below. This is a Google Earth display of the delayed reports described in paragraph 2.7 above observed from ANZ A20N aircraft in early 2021 and illustrating that most delays occurred around Norfolk Island.



2.17 A more detailed display of the delays observed around Norfolk Island is illustrated below. This also shows the information that can be displayed for each data point accessible by a mouse click on the data point.



2.18 The interface used to create the Google Earth files from the database or imported .csv files is illustrated below. The interface allows the user to select data points from the database or import a .csv file in GOLD format. The user then names the Google Earth file and selects the required icons and colours for each of three latency ranges (<90”, 90-180”, >180”) that can be displayed.



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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