International Civil Aviation Organization

The Second Meeting of the Regional Airspace Safety Monitoring Advisory Group (RASMAG/2)

Bangkok, Thailand, 4 – 10 October 2004

Agenda Item 5: Review regional and global airspace planning and implementation developments and provision of airspace safety monitoring services

VALIDATION OF APPLICABILITY OF ADS REPORT TO SURVEILLANCE

(Presented by JCAB CRA)

SUMMARY

This paper prepares a discussion material for the applicability of ADS report to surveillance, in the place of CPDLC or HF voice position report.

1. BACKGROUND

1.1 Tokyo ACC has been operating an oceanic ATC system named as the ODP (Oceanic Data Processing system) since 1997, which is an integrated ATC system with the full capabilities of ATS data link operation of ADS, CPDLC and AIDC.

1.2 Within the oceanic airspace out of VHF coverage in the Tokyo FIR, the CPDLC and ADS are the primary means of air/ground communication and surveillance for Tokyo ACC to deal with FANS-1/A equipped aircraft. Position reports by HF voice are not required when they are managed by CPDLC.

1.3 The communication efficiency can be improved by reducing human and system loads. For further benefit of FANS-1/A, Tokyo ACC intends to cease the usage of CPDLC position reports as well as HF voice, by using ADS reports (ADS waypoint change event reports) for the primary means of surveillance.

1.4 However, Tokyo ACC considers that it is necessary to conduct a feasibility study on the planned usage of ADS as the primary means of surveillance, when CPDLC position report is omitted, by monitoring the ADS and CPDLC data to verify the conformity of the ADS waypoint reports with the CPDLC waypoint reports. The CPDLC position reports are made with the fix names or coordinates that are published in the Jeppesen or the AIP (Aeronautical Information Publication).

2. PURPOSE OF THIS STUDY

2.1 The purpose of this study is to provide information for decision making on the feasibility of ADS report as the primary means of surveillance in the remote or oceanic airspace without using CPDLC waypoint report, by confirming the capability of the ADS report.

3. ANALYSES

3.1 The CRA (Central Reporting Agency) of Japan conducted an analysis on the applicability of ADS waypoint reports in the place of CPDLC position reports, to validate if the ADS report could be enough to take the role of primary means of surveillance. As the CPDLC position reports have been used successfully for years in Tokyo FIR, a comparison was made between ADS reports and CPDLC position reports, in terms of the conformity of ADS reports with CPDLC reports, by monitoring the actual data reported by aircraft.

3.2 The analyses were made regarding the following items:

a. Frequency of ADS reports down linked at ATC waypoints in comparison with that of CPDLC position reports
b. Correspondence of position data between ADS waypoint reports and CPDLC position reports

3.3 The total number of sampled data was nine-hundred and eighty-seven (987) consisting of ADS and CPDLC reports that were collected from the logs of Tokyo ACC Oceanic Sectors. The duration of data collection was from 0:00 through 23:59 Japanese local time on April 1st 2004 (15:00UTC of March 31 – 14:59UTC of April 1).

4. ATC WAYPOINT REPORTS AVAILABLE BY ADS

4.1 With 987 samples of ADS and CPDLC position reports, the analyses were made to determine if ADS reports can accommodate controllers with appropriate surveillance without CPDLC position reports.

4.2 From the total of 987 samples, 374 CPDLC data and 600 ADS data were employed for analyses except 12 CPDLC and one ADS data that were identified to be the re-sent and duplicated messages. (Table 1)

Table 1: Number of Messages of CPDLC/ADS

	CPDLC	ADS	Total
Number of Samples	386	601	987
Number of Samples used for Analysis	374 38.4 %	600 61.6 %	974 100 %
Duplicate (re-sent) Messages	12	1	13

4.3 In CPDLC operation, pilots downlink only the ATC waypoint (Compulsory Reporting Point) selected from the various messages displayed on the CDU. On the other hand, in ADS, all of the waypoints data generated by FMS are down-linked automatically without pilot's intervention. Therefore, ADS report includes the reports of non-ATC-waypoints that are all down-linked causing more frequent reports than CPDLC position reports.

4.4 Two-hundred and seventy-six (276) reports each for ADS and CPDLC corresponded each other and were identified to be the pair of ADS/CPDLC ATC waypoint reports.

Table-2: Number of ATC Waypoint and Other Position Reports

	CPDLC	**ADS**
ADS/CPDLC waypoint report associated with	276 (73.8%)	276 (46.0%)
Other Reports	97 (25.9%)	322 (53.7%)
Invalid Reports	1 (0.3%)	2 (0.3%)

4.5 Twenty-two (22) messages of 97 CPDLC position reports were the ATC waypoint reports that were down-linked in response to controller's requests or issued when the ADS contract requests were failed. The rest 75 messages were other sort of position reports that were made in accordance with the paragraph 5.8.4 (First position report) of FANS-1/A Operations Manual.

4.6 Therefore, the number of ATC waypoint reports via CPDLC was determined to be 299 in which 276 were simultaneously reported by the ADS, and, consequently, 22 ATC waypoints were missed to be reported by ADS. That is to say 92.3 percent of ATC waypoints were reported successfully by ADS and 7.7 percent were missing.

5. GEOGRAPHICAL CORRESPONDENCE IN ATC WAYPOINT REPORTS BETWEEN CPDLC AND ADS

5.1 The CPDLC position report is made with the published fix names or fix coordinates. Table-3 shows the analyzed data on the geographic difference in longitude/latitude between the CPDLC position reports and ADS waypoint change event reports.

Table-3: Geographical Difference of ADS reports from the published points in Longitude/Latitude

Difference in Longitude/Latitude	**Frequency**	**Percentage**
CPDLC/ADS reports corresponded each other	56	27.2%
1 min. longitudinal difference	18	8.7%
1 min. latitudinal difference	83	40.3%
1 min. of longitudinal both and latitudinal difference	42	20.4%
2 min. latitudinal difference	2	-
1 min. longitudinal l/2 min. latitudinal difference	1	-
2 min. longitudinal /1 min. latitudinal difference	1	-
3 min. longitudinal difference	1	-
5 min. longitudinal /1 min. latitudinal difference	1	-
5 min. longitudinal and 19 min. latitudinal difference	1	-

5.2 96.6 percent (%) of the ATC waypoint information was within one minute or less in the geographical difference of longitude and latitude, when the CPDLC position reports and ADS reports at ATC waypoints were compared. In Tokyo FIR, the difference of one minute in longitude is almost equivalent to 0.6 nautical miles. Also, 99.0 percent (%) of the ATC waypoint information were within the difference of 2 minutes in latitude or 3 minutes in longitude, the difference of which amounted roughly to two nautical miles.

6 DISCUSSIONS

6.1 The ATC operation requires the predicted data of aircraft at the next ATC waypoint, in addition to the current ATC waypoint. However, because of the characteristics of ADS waypoint report, the predicted data reported for the next waypoint is not always that of the ATC waypoint. Therefore, when CPDLC position reports are omitted and ADS waypoint reports became the primary means for surveillance, sometimes controllers may have to request the next ATC waypoint information to pilots using CPDLC or HF voice.

6.2 According to paragraph 4.6, 92.3 percent (%) of the required ATC waypoints were reported by ADS and 7.7 percent (%) were missing. In the case of overdue with missing ADS report, the controllers need to request the position reports to the aircraft by CPDLC or HF voice. To reduce controllers' workload, ATS end systems may need to be enhanced to detect the overdue status of aircraft and automatically take action requesting the position report via CPDLC.

6.3 It is believed that the omission of CPDLC waypoint report can lessen the workload of controllers and pilots as well as network load, even if they need to communicate sometimes with aircraft in overdue for verification of position report.

6.4 The omission of CPDLC waypoint position report reduces the ATS data link operational costs.

6.5 From a comparison of the difference between ADS waypoint reports and CPDLC waypoint position reports, 99.0 percent (%) were within the difference of two nautical miles or less, and 96.6 percent (%) was one nautical mile or less. The difference of two nautical miles is conceived to be the acceptable tolerance for safety in the oceanic ATC operation.

7. ACTION BY THE MEETING

7.1 The meeting is invited to discuss about the applicability of ADS reports to the primary means of surveillance in the place of CPDLC position reports.

References:

(1) ATS datalink CPDLC/ADS message logs, 1 March 2004, Tokyo ACC

(2) AIP Japan, ENR4.3 Reporting Point March 2004, JCAB

(3) ARINC Characteristics745 (ADS)

(4) FANS-1/A Operation Manual, 5. CPDLC Procedure

DATA ANALYSES

1. The total number of messages was 987 ADS reports and CPDLC position reports that were received at Tokyo ACC end system.

2. In these 987 messages, twelve (12) CPDLC and one ADS reports were determined to be the duplicate (or re-sent) messages. These duplicate messages were eliminated from the sample group and 374 CPDLC messages and 600 ADS reports were employed as the samples for analyses (Table 1).

Table 1: Number of CPDLC and ADS Messages

	CPDLC	ADS	Total
Total Number of Messages	386	601	987
Samples used for Analysis	374 38.4 %	600 61.6 %	974 100 %
Eliminated Duplicate Messages	12	1	13

3. Two-hundred and seventy-six (276) reports each for ADS and CPDLC were seemed to correspond with each other in the ATC waypoint reports.

Table-2: Number of ATC Waypoint and Other Position Reports

	CPDLC	ADS
Messages Corresponded in ATC Waypoint report	276 (73.8%)	276 (46.0%)
Other Position Report Messages	97 (25.9%)	322 (53.7%)
Invalid Reports	1 (0.3%)	2 (0.3%)

4. The position reports that were not associated with ATC waypoints were reviewed.

4.1 The ADS and CPDLC messages reported at non-ATC-waypoints were as follows:

* CPDLC 97 messages (25.9 % of CPDLC sample data)
* ADS 322 messages (53.7 % of ADS sample data)

4.2 With regards to these 97 CPDLC position reports that were <u>not</u> associated with those ATC waypoints, seventy-five (75) were identified to be the position reports down-linked soon after the connection establishment with ATS units, a practice according to the FANS-1/A Operations Manual. The remaining 22 messages were the reports responding to controllers' requests and those issued when ADS contract requests were failed.

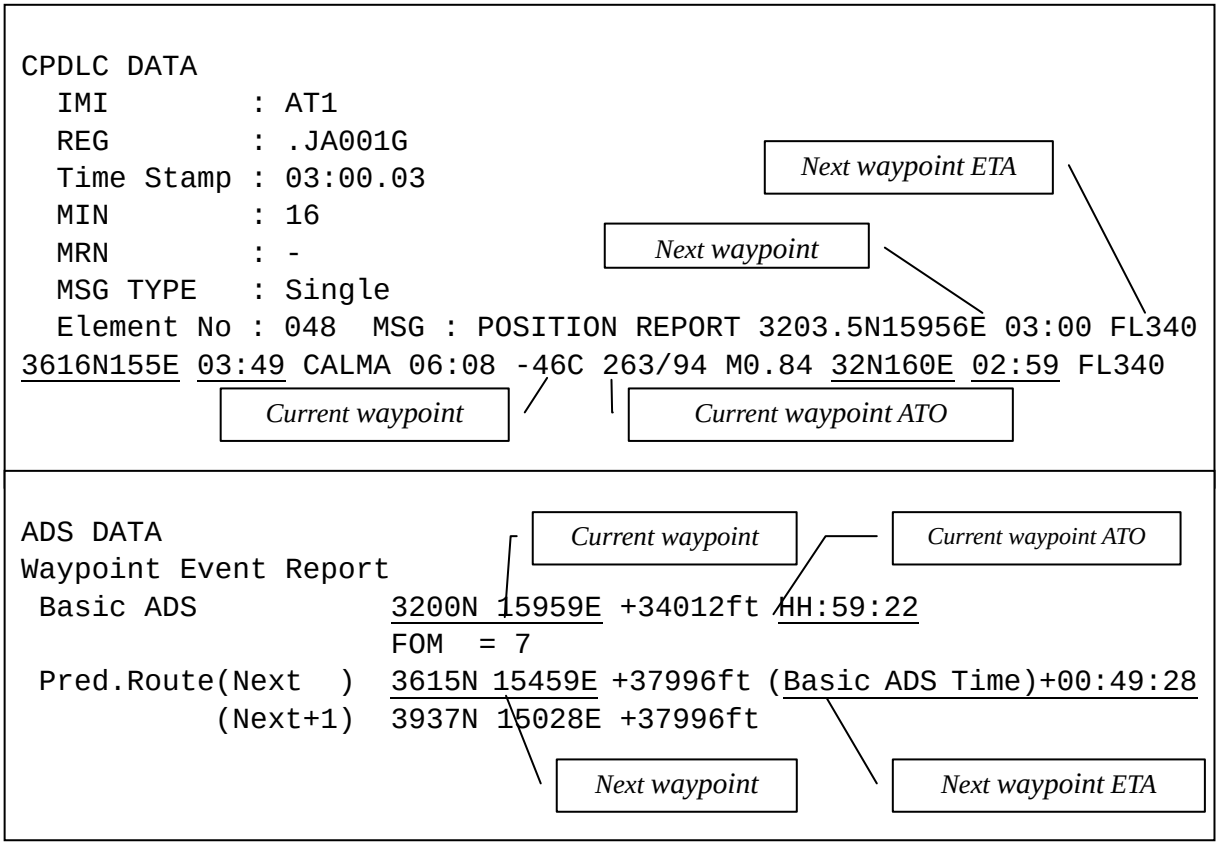
* CPDLC position reports based on the FOM (not ATC waypoint) 75 (77.3%)
* CPDLC ATC Waypoint reports with ADS contract failure 15 (15.5%)
* CPDLC ATC waypoint reports requested by controllers 7 (7.2%)

4.3 `Therefore, adding the number of CPDLC ATC waypoint reports of 276 in Table-2 and one invalid report and 22 reports mentioned at the previous paragraph 4.2, you get the total number of 299 CPDLC

ATC waypoint reports that should have been reported via CPDLC. Two-hundred and seventy-six (276) reports of 299 CPDLC position reports were accompanied by the corresponded ADS reports. From this fact, 92.3 percent of the required ADS reports at ATC waypoints were successfully received by the ATC end system.

5. The CPDLC position reports are made by pilots with the fix names or the coordinates of the fix that are published in the AIP/Jeppesen chart. The figure below shows the geographical difference between ADS waypoint change event report and CPDLC position report which data is collected at Tokyo ACC.

EXAMPLE: CPDLC POSITION REPORT AND ADS WAYPOINT CHANGE EVENT REPORT



— END —