Twenty-First Meeting of the Cross Polar Trans East Air Traffic Management Providers' Work Group (CPWG/21)

(Montreal, Canada, 17-20 May 2016)

Agenda Item 8: Communications, Navigation, Surveillance (CNS) and Air Traffic Management Issues

Future Air Navigation System (FANS) Anomaly related to a Boeing 787-900 Aircraft

(Presented by the Federal Aviation Administration)

SUMMARY

This paper provides information regarding an anomaly experienced by Anchorage Air Route Traffic Control Center (ARTCC) involving a Boeing 787-900 aircraft utilizing Future Air Navigation System 1/A (FANS 1/A) equipment and procedures.

1 Introduction

1.1. On March 23, 2016 Anchorage ARTCC experienced a loss of standard oceanic separation between two aircraft flying over the Pacific Ocean approximately 1300 nautical miles (nm) west of Anchorage, Alaska. While not the proximate cause, the event investigation revealed that an associated anomaly had occurred with one of the aircrafts' FANS messaging (ADS-C and CPDLC). The goal of this Information Paper is to provide the Cross Polar Working Group in general, and the Air Navigation Service Provider members in specific, information as to the specific FANS anomaly and a background of how the event investigation was accomplished.

2 Background

2.1. In the early evening (local time) on March 23rd, Anchorage ARTCC's Sector 10 was providing ATC separation service for the westbound NOPAC traffic flow which included ATS route R220 and Pacific Organized Track System (PACOTS) routes Charlie and Echo. Most of the aircraft in the sector (20+) were FANS equipped and the ARTCC's Advanced Technologies and Oceanic Procedures (ATOP) computer system had established Automatic Dependent Surveillance Contracts (ADS-C) with them. Many of these aircraft, including pair "A" and "B", were being provided reduced longitudinal separation predicated on their FANS equipage.

2.2. At time 02:04:30, a routine, periodic ADS-C position report was received from aircraft "B". ATOP's Conflict Prediction and Reporting subroutine (CPAR), determined that the longitudinal distance between "A" and "B" was more than 37nm and, although aircraft "B" was maintaining a slightly higher speed, longitudinal separation between "A" and "B" was calculated to remain greater than 30nm (the separation standard minima) for at least the next 2 hours.

2.3. At time 02:14:06, the ATOP conformance monitoring sub-routine identified that the next expected ADS-C periodic position report from aircraft "B" had not been received. In accordance with ICAO Standards and Recommended Practices (SARPS) for ADS-C separation[1], ATOP is programmed to "wait" 3 minutes in anticipation of the missing position report being received late. At the expiration of the 3 minutes, and again in accordance with SARPs, ATOP automatically sent aircraft "B" an "on demand" request for a one-time ADS-C position report. At time 0220:12, when still no ADS-C position

[1] ICAO Document 4444, Paragraph 5.4.2.6.4.3.3

report had been received from “B”, the ATOP system simultaneously alerted the Sector 10 controller of the overdue position report and automatically degraded aircraft “B’s” eligibility for ADS-C 30nm separation. At this point, a “technical” loss of separation between aircraft “A” and “B” had occurred and, per ICAO SARPs, the controller had 6 ½ minutes to establish a different form of separation between the two. The controller subsequently determined to establish vertical separation between “A” and “B” and, using Controller/Pilot Data Link Communications (CPDLC), transmitted a climb clearance to aircraft “B”. The CPDLC climb clearance was not acknowledged. Because of this, and subsequent mis-steps by the controller, an unannounced Mach .04 speed increase by “B”, and the receipt of a stale ADS-C position report, losses of separation occurred between “B” and another westbound aircraft, “C”, and again between “A” and “B” before full separation was restored.

2.4. While these paragraphs necessarily give a condensed, “short story” report of the event, they provide the necessary background for understanding the FANS discussion which follows.

3 Discussion

3.1 While the investigation of the separation losses described above concentrated on controller and pilot actions, the FANS anomalies (missing and late ADS-C position reports and unanswered CPDLC messages) were quickly identified as key factors. The forensic data captured by ATOP reports only the ATSU side of the FANS transactions; i.e. it records only the ADS-C and CPDLC transmissions sent to, and received from, an aircraft. Data concerning both the aircraft inner workings (cockpit and avionics) and the FANS transmission modalities (ground to ground “inter-networking, Ground Earth Stations, INMARSAT and Iridium satellite networks, etc.) must be obtained elsewhere.

3.2 In 1997, recognizing the ICAO requirements for post FANS implementation monitoring, the Informal South Pacific Air Traffic Services Coordinating Group (ISPACG) established a Central Reporting Agency (CRA) which was given the responsibility for end-to-end safety and performance monitoring of Air Traffic Services (ATS) datalink systems in the Asia/Pacific Region. The ISPACG CRA has developed working relationships with both aircraft and avionics manufactures as well as aircraft operators. These relationships usually allow the CRA to obtain FANS data from all parties involved in a FANS messaging transaction.

3.3 As part of its investigation, Anchorage ARTCC reported “B’s” missing / delayed ADS-C and CPDLC messages to the CRA. Less than 24 hours after receiving the report, the CRA was able to identify the likely causality. The CRA reported that there was a known issue with “B’s” (a B787-900) avionics which, when triggered by an uplinked ATS Facilities Notification (AFN) message containing an embedded network acknowledgement, causes the avionics to delay sending any further FANS messages for 10 ½ minutes. Additionally, the delayed FANS messages are transmitted out from the avionics in the order they were initially prepared. In “B’s” case, this meant the missing ADS-C position report was delayed even further.

3.4 Figure 1 (taken from FAA’s ATOP Operator Manual) is modified to show where in the process of FANS Address Forwarding the “embedded” network acknowledgement message occurred. Note that the FANS messaging which accomplishes Address Forwarding and initial system logon occurs independently of any other FANS messaging which may be occurring for ADS-C and CPDLC. What this means is, the timing of an ADS-C or CPDLC message is independent of when an AFN message may occur. The fact that the missing ADS-C position report (due at 02:14:06) was delayed by more than 10 ½ minutes is due to the timing of AFN address forwarding process. If the FN_ACK message, containing the “embedded network acknowledgement”, had been received by the aircraft after 02:14:0*7* (instead of slightly before it) the position report would have been transmitted and the entire sequence would have been avoided. As it was, the FN_ACK was received by the aircraft at 02:13:17 which caused the avionics to stop sending

FANS messages, the ADS-C position report to become overdue, ATOP to degrade the aircraft's qualification for ADS-C 30nm separation, the notification to the controller to establish another form of separation, and, unfortunately, the controllers following mis-steps in accomplishing that task.

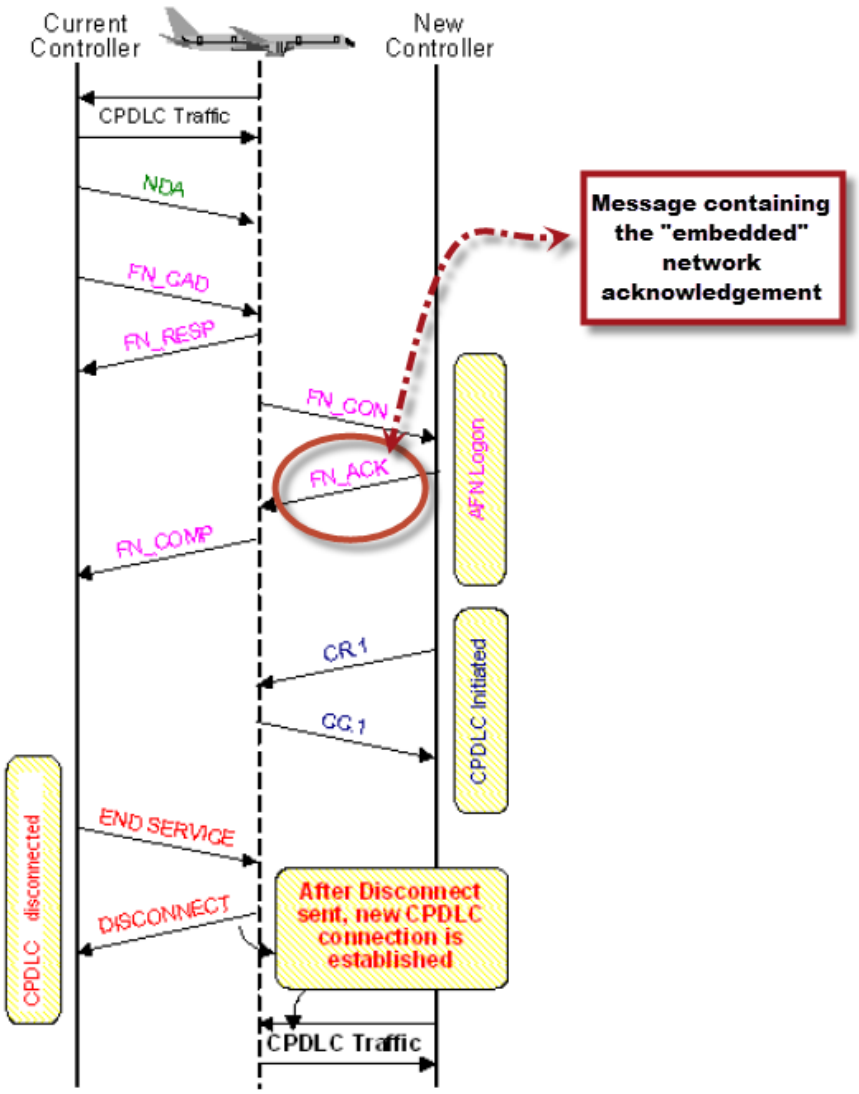

Figure 1. Transfer of FANS Communication Process

4 Final Note

4.1 Boeing advises that a software patch for the B789 avionics issue discussed above has been incorporated into a Communication Management Function (CMF) software release which should be available to operators via a Service Bulletin by first quarter 2017.

5 Recommendation

3.1. The Meeting is invited to note the information provided in this paper.