Thirty Eighth Meeting of the
Informal South Pacific ATS Coordinating Group
(ISPACG/38)

Thirty First Meeting of the
FANS Interoperability Team
(FIT/31)

Santiago, Chile
4-6 June 2024

Agenda Item 8: Information Papers

ACARS RAT1 FUNCTION

Presented by the Central Reporting Agency (CRA)

SUMMARY

This paper describes the Aircraft Communications Addressing and Reporting System (ACARS) Routing Airborne Timer 1 (RAT1) function.

1 INTRODUCTION

1.1 Considering that the CRA has referenced the ACARS RAT1 function on several occasions, the CRA believes that a description of the function is of interest to the ISPACG FIT.

2 DISCUSSION

2.1 ACARS Design and PBCS Time Requirements

a) ACARS avionics are typically designed and configured to minimize costs to aircraft operators by preferring less expensive VHF links over more expensive SATCOM links. Use of SATCOM links can cost as much as 12 times more than use of VHF links.

b) This approach predates the PBCS concept by about 20 years but has sometimes proven to be problematic for PBCS compliance because the ACARS avionics minimizing cost by preferring VHF links over SATCOM links can cause PBCS time requirements to not be met.

c) According to the ACARS protocols defined in ARINC Specification 618, typically designed and configured ACARS avionics persistently attempt to use a VHF link before considering it to be unavailable and transitioning to using a SATCOM link. These protocols specify a combination of counters and timers such that the avionics attempt to deliver a downlink via a VHF link a certain number of counter-defined times at a specific timer-defined interval before considering the VHF link to be unavailable.

d) In the relatively simple "Plain Old" ACARS (POA) Category A case for VHF, the ACARS avionics attempt to deliver a downlink between three and eight times (defined by VHF Airborne Counter 1 [VAC1]) at a randomized interval between 10 and 25 seconds (defined by VHF Airborne Timer 7 [VAT7]) before considering the VHF link to be unavailable.

e) If the ACARS avionics use an average VAC1 value of 6 and an average VAT7 value of 17.5 seconds, then they attempt to deliver a downlink via VHF for 105 seconds before considering VHF to be unavailable and attempting to deliver the downlink via SATCOM. Notably, the downlink-only RSP180 95% delivery time requirement is 90 seconds and half of the uplink plus downlink RCP240 95% transaction time requirement is 105 seconds. This means that when the avionics attempt but fail to successfully deliver a downlink via VHF – such as when the airplane has exited VHF datalink coverage since sending the previous downlink but the avionics are not yet aware that the VHF link is no longer available – those time requirements may not be met. Figure 1 depicts this behavior in a message sequence diagram.

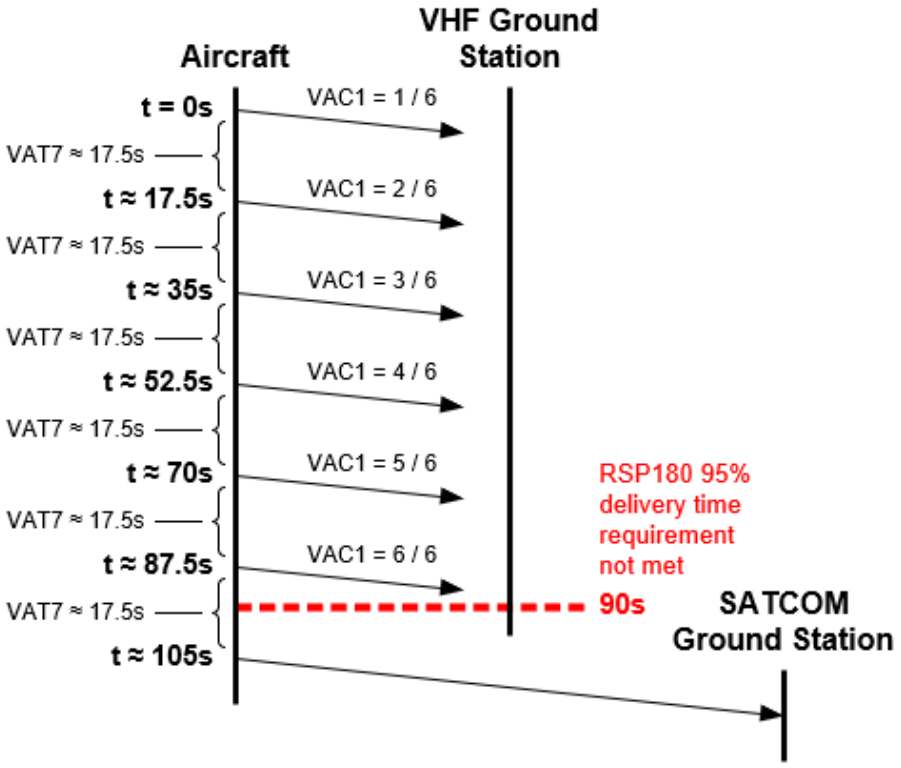

Figure 1

f) Of note, this behavior can make time performance via SATCOM appear to be bad when in reality the time performance via SATCOM is good but the time performance via VHF is bad. This is due to the time required by the ACARS avionics to attempt but fail to deliver a downlink via VHF and then revert to delivering the downlink via SATCOM, as Figure 1 depicts.

2.2 RAT1 Development

a) The collective ISPACG FIT CRA, FAA IPACG FIT CRA, FIT-Asia CRA, and NAT DLMA (namely Boeing) initially became aware of these challenges starting in 2012 with problem reports such as PR 1174-GS. For that problem report, Figure 2 below depicts the positions contained in ADS-C reports that were delivered via SATCOM but were delayed by more than 90 seconds with downward-pointing orange arrows. Notably, these arrows generally lie at the approximate edges of nominal VHF datalink coverage depicted as large orange circles.

Figure 2

b) After additional similar problems were reported, in 2013 Boeing made the AEEC Data Link Systems Subcommittee (the industry group responsible for the ACARS technical standards, including ARINC Specification 618) aware of the problem and proposed that the group modify ARINC Specification 618 to improve time performance for RSP180 and RCP240 while still minimizing costs to aircraft operators.

c) After Boeing led the group through discussing several potential solutions from 2013 to 2015, the group developed and added the RAT1 function to ARINC Specification 618 Supplement 8 that was published in 2016. This function causes the ACARS avionics to route a FANS AFN, CPDLC, or ADS-C downlink via SATCOM if the avionics have not successfully delivered the downlink via VHF after 60 seconds. This time value was chosen as a balance between giving the avionics a reasonable amount of time to attempt to deliver the downlink via VHF while still meeting the PBCS time requirements, particularly the RSP180 95% delivery time requirement of 90 seconds. Some avionics may also allow the RAT1 time value to be configured within a reasonable range.

d) Figure 3 below depicts RAT1 behavior in a message sequence diagram. Of note, RAT1 slightly increases the probability that an ATS provider may receive the same FANS downlink twice (once via VHF and once via SATCOM) because the ACARS avionics continue to attempt to deliver the downlink via VHF even after routing the downlink via SATCOM according to RAT1. This already occurs occasionally due to other reasons, however.

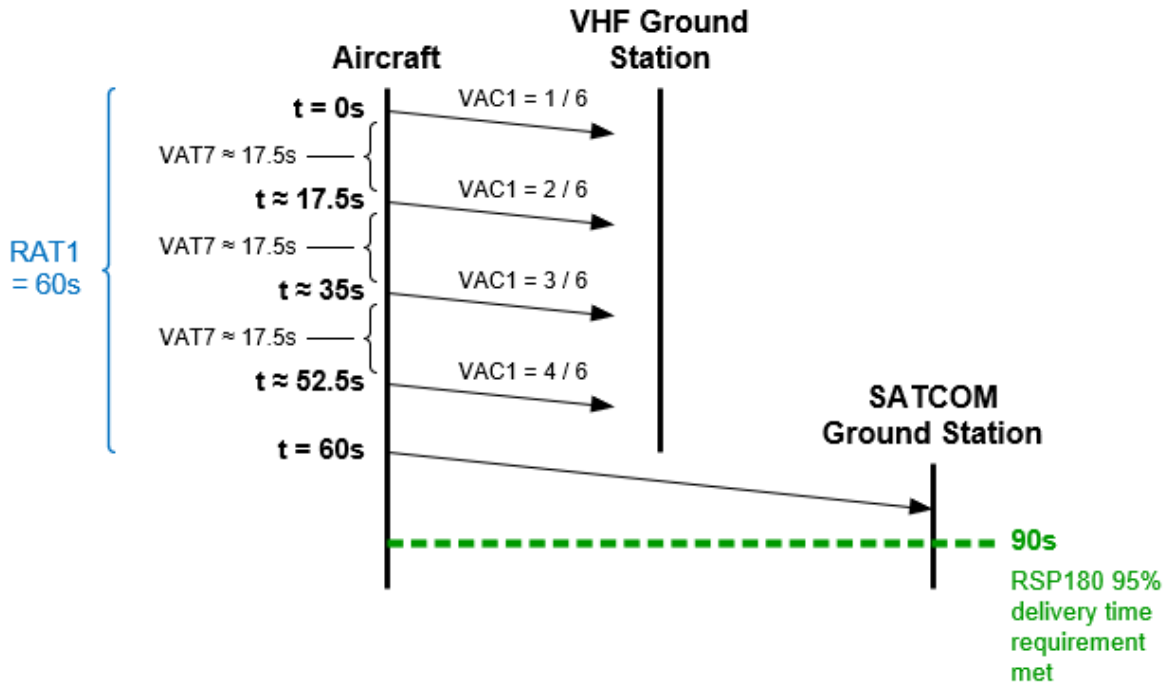

Figure 3

2.3 RAT1 Implementation

a) For 737, 747, 757, 767, and MD-11 aircraft, the RAT1 function is available in newer Collins CMU-900 and Honeywell CMU Mark II software. Aircraft operators may obtain further details from Collins and Honeywell.

b) For 777 aircraft, the RAT1 function will be available in AIMS-2 BPV18 software that Boeing expects will become available in Q3 2024. For 777X aircraft, the RAT1 function will be available in CMF software at initial certification and entry into service. For 787 aircraft, the RAT1 function will be available in CMF BPv7 software that Boeing expects will become available in Q1 2026.

c) For A320, A330, A340, A350, and A380 aircraft, the RAT1 function is available in newer avionics software. Aircraft operators may obtain further details from Airbus.

d) Figure 4 below depicts nominal VHF datalink coverage in Japan and the positions contained in three ADS-C reports for which 777X ACARS avionics invoked the RAT1 function during a southwest-bound flight from Seattle to Singapore for the Singapore Airshow in February 2022. The figure shows how the airplane approached VHF datalink coverage in Japan at a shallow angle, which placed the airplane in weak VHF datalink coverage for an extended period of time. In each of these three cases, the ADS-C report delivery times were 62 seconds (60 seconds for the RAT1 function and 2 seconds for delivery via Inmarsat SwiftBroadband-Safety SATCOM). These delivery times met the RSP180 95% delivery time requirement of 90 seconds, but the delivery times without the RAT1 function likely would not have met that requirement.

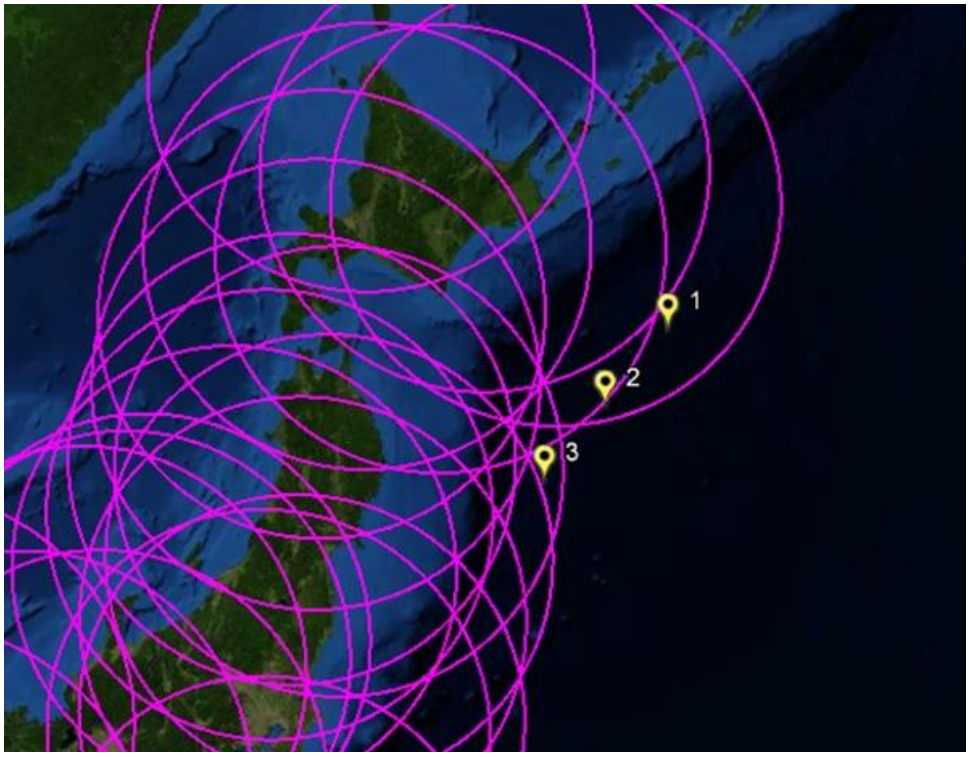

Figure 4

e) Figure 5 below depicts nominal VHF datalink coverage in the South China Sea and the position contained in an ADS-C report for which 777X ACARS avionics invoked the RAT1 function during a northeast-bound flight from Singapore to Seattle following the Singapore Airshow in February 2022. The figure shows how the airplane recently exited VHF datalink coverage over the South China Sea. In this case, the ADS-C report delivery time was 62 seconds (60 seconds for the RAT1 function and 2 seconds for delivery via Inmarsat SwiftBroadband-Safety SATCOM). This delivery time met the RSP180 95% delivery time requirement of 90 seconds, but the delivery time without the RAT1 function likely would not have met that requirement.

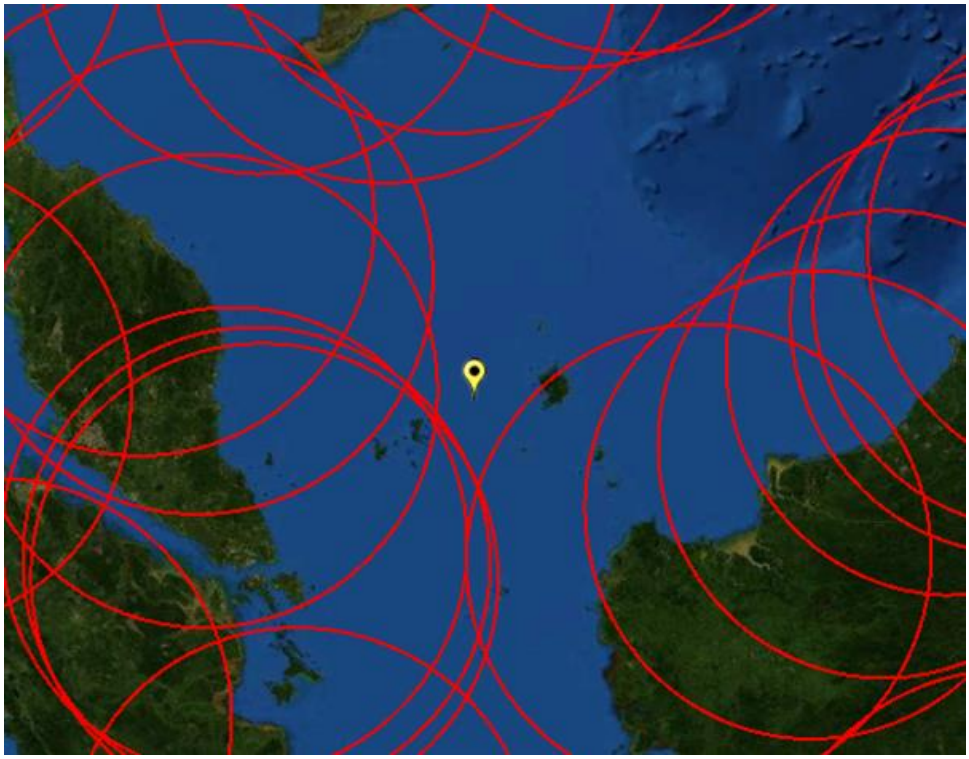

Figure 5

f) This real-world behavior provides confidence that the ACARS RAT1 function will perform as intended by improving time performance for RSP180 and RCP240 while still minimizing costs to aircraft operators.

3 ACTION BY THE MEETING

3.1 The CRA invites the ISPACG FIT to note the content of this paper.