Honeywell

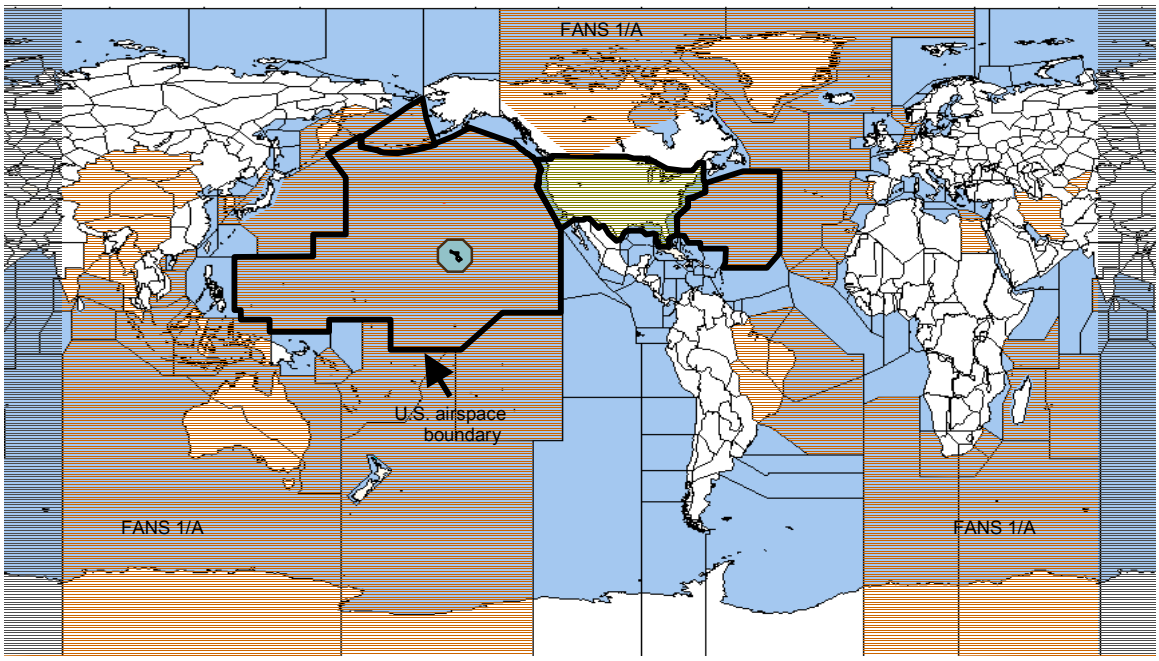
Future Air Navigation System (FANS)

Introduction

Future Air Navigation System (FANS) is a concept that was developed by the International Civil Aviation Organization (ICAO) in partnership with Boeing, Airbus, Honeywell and others in the air transport industry to allow more aircraft to safely and efficiently utilize a given volume of airspace. Today FANS is used primarily in the oceanic regions taking advantage of both satellite communication and satellite navigation to effectively create a virtual radar environment for safe passage of aircraft. FANS plays a key role in supporting many of the evolving CNS/ATM (Communication, Navigation, Surveillance / Air Traffic Management) strategies and mandates – an evolution that has been underway for more than ten years. Today, FANS-1 is the standard used on Boeing aircraft while the Airbus standard is known as FANS-A. Both are considered first generation FANS architectures. Second generation FANS will be discussed under the FANS Evolution paragraph.

The first FANS routes made their debut in the Pacific in early 1996 and were originally flown by three airlines with the Boeing 747-400. These B-747 FANS 1 equipped aircraft use Global Positioning System (GPS) satellites and Inertial Reference Systems (IRS) to fix their position and an on-board Honeywell Flight Management System (FMS) to manage the navigation solution and flow of information. The position of the aircraft is then transmitted through a communications router and sent to Air Traffic Control (ATC) via either VHF or SATCOM. The FANS standard mandates the use of INMARSAT SATCOM when out of VHF range. This *Communication* (VHF or SATCOM), *Navigation* (GPS / FMS) and automatic dependant *Surveillance* (ADS-A) concept enables ATC to create a clear picture of the traffic in a given block of oceanic airspace much in the same manner as ground-based radar does today over land.

FANS routes have expanded mightily from the first North America - South Pacific routes in 1996. Today there are over 34 Flight Information Regions (FIRs) and Upper Information Regions (UIRs) around the globe supporting ATC surveillance (ADS-A) and Controller Pilot Data Link Communication (CPDLC), providing FANS coverage worldwide (Figure 1). This expanded coverage gives airliners and long-range business jets the option to select direct routes over many of the highly traveled oceanic regions (Atlantic and Pacific) and utilize FANS procedures globally. Polar routes have also been established that maintain FANS continuity when out of radar coverage. When comparing the differences of today's traditional voice reporting system to FANS, the obvious advantage is being able to place more aircraft in the same airspace and do it *safely*. The uncertainties of voice reporting and the delay associated with HF radio require the air traffic controller to allow a tremendous amount of airspace between each airplane, typically 100 nm laterally and 120 nm longitudinally. With FANS and the recent Required Navigation Performance (RNP) mandates, air traffic controllers can safely and significantly reduce those separation distances and allow more flexibility for the FANS-equipped aircraft.



Graphic courtesy of The Boeing Company Figure 1

FANS Components

The term FANS encompasses a set of defined software features required within the FMS. Changes within these features have improved since 1996 based on thousands of hours of pilot and ATC usage to ensure all aspects of CNS/ATM are satisfied safely and efficiently. The current FANS features Honeywell develops for its line of FM systems are:

AFN – Air Traffic Services (ATS) Facilities Notification: AFN contains the protocol within the FMS for the aircraft to log-on to a ground facility and establish ADS-A or C surveillance. AFN also provides a link between providers to enable automatic handoff between regions.

ADS-A or ADS-C – Automatic Dependant Surveillance-Addressed or Automatic Dependant Surveillance-Contract: ADS-A/C contains the software algorithms to transmit the position of the aircraft (either via SATCOM or VHF) every one to five minutes to an ATC listening station (typically within the FIR). ADS contracts are established by the ground station following a logon from an aircraft. Although ADS and CPDLC are separate applications, they both use the same logon from the aircraft for their own purposes. ADS-A will also maintain surveillance continuity through automatic handover across FIR boundaries.

CPDLC – Controller / Pilot Data Link Communication: CPDLC is the data link software algorithm within the FMS that enables two-way communication between the cockpit and ATC. It contains the set of predefined text messages for clearances, requests and routine message traffic. The current FANS CPDLC is designed to use the ACARS network much in the same manner that AOC (Airline Operational Control) is used today. But rather than route message traffic to an airline operational center, the CPDLC is routed from the cockpit to ATC based on handling instructions within the aircraft CMU (Communications Management Unit).

RNP – Required Navigation Performance: RNP containment is now required in certain oceanic regions throughout the globe. RNP has been a component of FANS since inception. Global Position System (GPS) and Inertial Reference System (IRS) combined with FMS provide compliance with RNP mandates now in effect. RNP 4 and 10 (4 and 10 NM lateral contain containment) are typical in oceanic regions. Actual RNP is continually monitored by the flight crew and they are notified of any exceedance. The flight management systems developed by Honeywell meet all FANS-related RNP mandates now in effect.

RTA – Required Time of Arrival: RTA gives the flight crew the ability to assign a time constraint to a waypoint, allowing the aircraft to cross a latitude or longitude at a specified time. The cruise speed is automatically adjusted by the autothrottle to achieve the RTA plus or minus 30 seconds. If the RTA is not possible, the flight crew is notified with a visual alert.

Flight Plan Updates – The FMS will have the capability to update the flight plan based on revised clearances received by ATC via CPDLC. The flight crew would acknowledge the clearance and the active flight plan would be updated.

Benefits to Business Jets

With the exception of a small number of Boeing Business Jets (BBJs), the business jet community as a whole has not taken advantage of the growing FANS infrastructure. The super long range business jet aircraft, predominantly the Gulfstreams, Falcons and Bombardier family, have yet to certify a FANS system despite having most of the avionics hardware (such as SATCOM, GPS and FMS) already onboard. The business case to install FANS systems on these long range jets is currently being made around a set of benefits and paybacks. The airlines have reaped these benefits for many years and business jets are benefactors of the pioneers of the early FANS routes. The benefits offered by FANS include reduced fuel burn and flight time through more efficient routing and increased payload capability for takeoff-weight-limited flights. If FANS were implemented on business jets, operators would be able to take advantage of several needed improvements:

1. Reduced separation between airplanes
2. More efficient route changes
3. Satellite communication
4. No altitude loss when crossing tracks
5. More direct routings
6. Reduced user charges for using the FANS infrastructure

Reduced Separation Between Airplanes

In non-FANS procedural airplane separation, errors in navigation and potential errors in voice communication between the flight crew and air traffic control are considered when determining the necessary airspace separation between airplanes. The uncertainties of traditional voice position reporting and the delay associated with high-frequency relayed voice communications (10 to 20 minutes to make a high-frequency voice position report) require the air traffic controller, in the pre-RNP / FANS era, to allow a tremendous amount of airspace between each airplane – typically 100 nm laterally and 120 nm longitudinally. This computes to 48,000 square miles of airspace to protect on airplane and means that airplanes often operate at less-than-optimum altitudes and speeds.

In contrast, through a satellite data link, airplanes equipped with FANS can transmit automatic surveillance reports with actual position and intent information at least every one to five minutes. The position is based on the highly accurate Global Positioning System (GPS). Digital data communication between the flight crew and the air traffic controller drastically reduces the possibility of error and allows greatly reduced airplane separations. The combination of improvements in the communication, navigation and surveillance allows authorities to reduce required separation distances between airplanes, which in turn allow airplanes to fly at their optimum altitude and burn less fuel.

More Efficient Route Changes

Oceanic operations currently are based on weather data that are up to twelve hours old. By using the satellite data link, the latest weather from a variety of weather services is transmitted to the airplane while en route. Flight crews can then use these data to develop optimized flight plans or those plans can be generated on the ground and transmitted to the airplane. Such dynamic re-routing may allow airlines and business jets to consider reducing discretionary fuel, which further reduces fuel burn or allows increased payload.

Satellite Communication

Satellite communication provides a much more reliable link to the ground than current high frequency (HF) radio, which is susceptible to noise and interference. SATCOM reduces the response time to a few minutes for an airplane requesting a step climb to a new, optimum altitude to reduce fuel burn. Response time can vary from 20 to 60 minutes based on the existing separation distances required. Through SATCOM, the flight crew no longer has to rely on the HF radio. Communication is efficient, silent and automatic.

No Altitude Loss When Crossing Tracks

To avoid potential conflict, an airplane that is approaching crossing tracks must be separated by altitude from any traffic on another track. As a result, one of the two airplanes can be forced to operate as much as 4,000 feet below optimum altitude. But if the air traffic controller has timely surveillance data via FANS from both airplanes, including projected intent, and the airplanes are able to control their speeds so that they reach crossing points at a given time (RTA) then altitude separation becomes much less frequent.

More Direct Routings

In many cases, current air traffic routings are compromised to take advantage of existing navigation aids and radar coverage resulting in less-than-optimum routings. DARP (Dynamic Aircraft Route Planning) and User Preferred Routings are available for FANS equipped airplanes. Taking advantage of space-based communication, navigation and surveillance (CNS) allows more direct (e.g.: shorter) routes. With FANS onboard, operators can benefit from reduced fuel burn and flight time as well as increased payload capacity for takeoff weight-limited flights. As a result, costs associated with crew and engine maintenance can be reduced allowing operators to reinvest the money savings elsewhere.

Reduced User Charges for Using the FANS Infrastructure

Some ANSPS (Air Navigation Service Providers) that currently charge for using HF flight-following services will offer a reduced rate for FANS / CPDLC services due to improved handling efficiencies on the ground.

Typical FANS Architecture

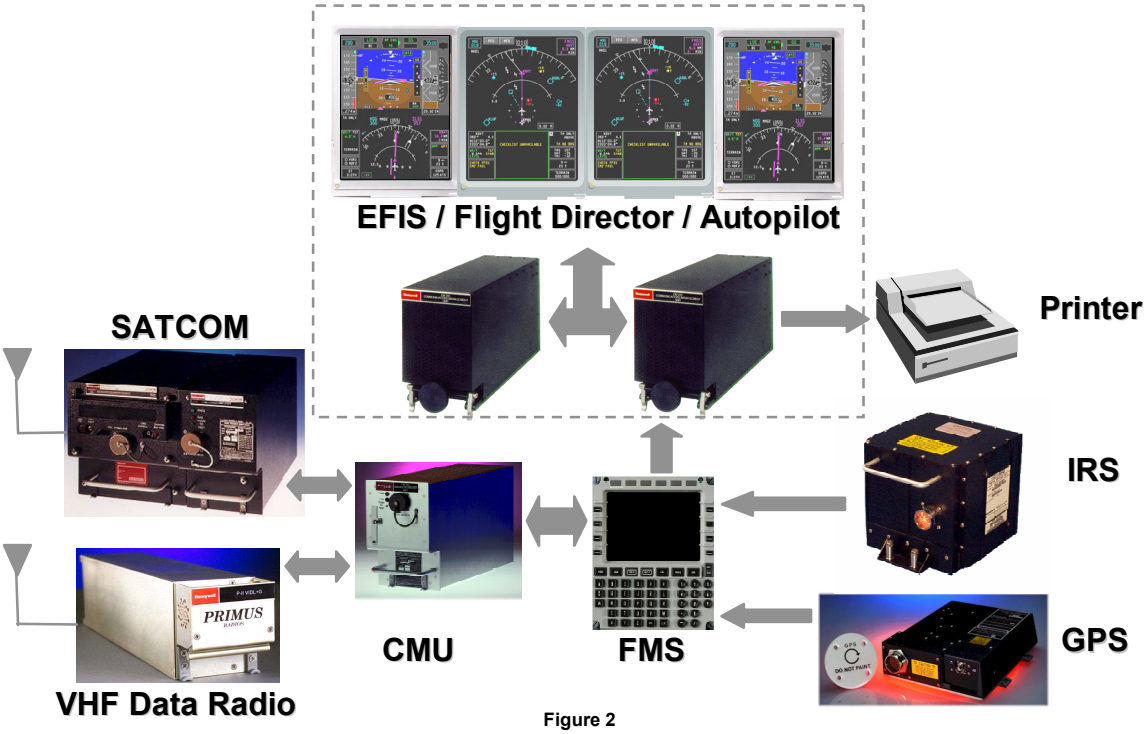


Figure 2

The basic hardware building blocks for FANS (Figure 2) are found on many of the newer long range business jets today. In most cases, the upgrade to FANS involves loading only the FANS software in the FMS. The following is a closer look at the FANS requirements from an LRU perspective.

Flight Management System (FMS) – the FMS will receive a comprehensive software load that should include the following components (if not already part of a previous software load):

- RNP-RNAV – Required Navigation Performance standards are necessary to maintain the navigation performance in the particular oceanic region that supports FANS. The upgrade involves adding RNP software and display of RNP status on the CDU or MCDU (Multi-function Control Display Unit).
- RTA – Required Time of Arrival enables the pilot to define a waypoint with a specific arrival time plus or minus 30 seconds. If the aircraft cannot meet the 30 second requirement, the flight crew will be notified.
- ADS-A/C – Automatic Dependant Surveillance information is output by the FMS. This information is sent to ATC and includes position, time, altitude and intentions.
- AFN – ATS Facilities Notification enables the log-on and handover of the FANS-equipped airplane to the ATC ground facilities.
- CPDLC – Controller Pilot Data Link Communication contains the stack of predefined messages and formats on the (M)CDU that allow the pilot to communicate with ATC. Clearances and messages are exchanged via the CPDLC standards and protocols

Satellite Communication (SATCOM) – FANS requires *Inmarsat* SATCOM to be used when out of VHF range. Honeywell's MCS-series of SATCOM meets this requirement and has been used in FANS installations since 1996. Most long range business jets today are fitted with Honeywell SATCOM obviating the need for this costly equipment to be added once the FANS software is loaded on the aircraft. It is important to note that a SATCOM for intended use with FANS must be certified to meet DO-178B Level D software requirements. DO-178B Level E software, which can be found on other manufacturer's SATCOM, is not certified to meet FANS requirements. Honeywell SATCOM meets DO-178B Level D today.

Communications Management Unit (CMU) – the Honeywell Mark III CMU (and CMF for Primus Epic® platforms) contains the necessary ARINC 622 and 623 protocols to properly route the FANS messages to ATC via the ACARS network. Many in-service long range business jets today instead have a Honeywell DMU (Data Management Unit) used for AFIS / ACARS messaging. Honeywell is developing a software modification for the DMU that will add the A-622/623 protocol which will preclude a mandatory upgrade to an ARINC-style CMU such as the Honeywell Mark III. However, as FANS protocols evolve to the new ATN / FANS 2 concept (see below under FANS Evolution), the Honeywell DMU will not be upgradeable and a new CMU will be required.

EFIS / Flight Director / Autopilot – it is anticipated that there will be no modifications required to the EFIS / FD / AP system software if the aircraft is equipped with an (M)CDU. Without a dedicated (Multifunction) Control Display Unit (M)CDU such as the MC-850 or CD-820 in the cockpit, changes will be required to the EFIS to replicate the FANS pages on the large cockpit displays. This is potentially a large development effort. In the case of a CD-810-equipped aircraft, the CD-810s will have to be replaced with the CD-820 to gain access to the special ATC key. The existing MC-850 MCDUs should not need modification.

Printer – a printer is required in the event the flight crew needs to print a clearance received or sent over FANS data link. Most long range business jets have on-board printers today.

FANS Evolution

Both Boeing and Airbus have plans to meet the second generation FANS definition with their FANS 2 (Boeing) and FANS B (Airbus) solutions. Both FANS 2 and FANS B architectures will be based on the new ATN (Aeronautical Telecommunications Network) protocol. ATN will relieve the slower FANS-over-ACARS network in use today. New, higher speed CPDLC is currently being tested over the continent of Europe with CMUs running the ATN protocol and communicating via higher speed VDL Mode 2 transceivers. This trial program, called Link 2000+, has over 200 pioneers and early adopters and is showing remarkable success. FANS 2 and FANS B will use the CMU-based ATN protocol which will provide a faster, more reliable data link. This will speed up messaging as well as add more data capacity. Currently, there are 80 downlink and 180 uplink messages with FANS 1/A. FANS 2/B will support growth in this area, if needed.

If Link 2000+ completes all of its objectives, a mandate for ATN / CPDLC could come as early as 2010 in blocks of airspace over Europe. Initially, the oceanic FANS routes will be interoperable serving both ATN and ACARS FANS architectures. However, the future is unclear how long ICAO, ECAC and the FAA will continue to allow use of ATC services over the ACARS network.

Summary

The benefits of FANS are clear. The three airlines that pioneered the use of FANS beginning in 1996 have paved the way for over 35 carriers flying 1,000 FANS-equipped aircraft today. The fuel savings, added payload, time en route reduction and maintenance cost savings clearly make a case for payback of the FANS equipage. With this proven savings model, business jets are assured of the same benefits as the airlines. And to make the equipage of FANS even more attractive, most of (if not all) the hardware is already onboard. The ideal candidate long range business jet will have the FMS, GPS, CMU / DMU, SATCOM and VHF Data Radio installed today. Only FMS software (and possibly DMU software) will need to be upgraded. Other aircraft may need to add a DMU or CMU and / or upgrade their existing CDU. FANS will continue to evolve to support higher system capacity beyond 2010. FANS 2/B is on the horizon and will follow the success of the Link 2000+ trials in Europe.

Honeywell Aerospace
21111 N. 19th Avenue
Phoenix, AZ 85027
North America: 1-800-601-3099
International: +1 602-365-3099
www.honeywell.com