

Understanding the Future Air Navigation System (FANS) 1/A Operations and Regulatory Requirements

White Paper

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Executive Summary

Efforts to promote Future Air Navigation System (FANS)-enabled avionics, establish equipage mandates and further develop it as a Communication, Navigation and Surveillance / Air Traffic Management (CNS/ATM) concept has been ongoing for years.

The technology has been utilized in the North Atlantic for over three decades, originally rolled out as a cost saving feature from aircraft OEMs. Recently, US and Canadian authorities have sought to establish FANS 1/A technologies in continental airspace in order to more effectively manage airspace congestion and improve safety. Concurrently, the feasibility of FANS as both a forward fit and retrofit installation for business jets has become a reality.

What is FANS 1/A?

The Future Air Navigation System (FANS) provides a means for direct communication between the pilot and Air Traffic Control (ATC) through data link technology. Very High Frequency (VHF) radio or satellite communication (SatCom) systems are used to enable digital transmission of short, relatively simple messages between the aircraft and ATC. Types of data communications can include: oceanic clearances, pilot requests, and position reporting.

Development of FANS 1/A

In order for aircraft to fly across oceanic/remote areas of airspace, a method of communication had to be established to manage aircraft out of range of traditional ground-based VHF radar systems for an extended period of time.

For decades, the only means of communication in remote/oceanic airspace had been a High Frequency (HF) radio system that uses line of sight or the atmosphere to bounce the transmissions to the recipient. The pilots report their position to a radio operator who, in turn, relays the aircraft position report over a telephone line to the ATC. HF Radio is known to be problematic due to noisy transmissions caused by atmospheric conditions, and language barriers.

FANS provided an improvement to HF Radio Communication in these areas by using data link communication through satellite communications. The existing satellite-based Aircraft Communications Addressing and Reporting System (ACARS) was used during the first implementation of FANS.

As far back as 1983, industry officials concerned about the rise in air traffic sought to address an aging infrastructure, unable to effectively handle increasing congestion. Responding to the issue, the International Civil Aviation Organization (ICAO) established the Special Committee on FANS, which was tasked with identifying new technologies for the future development of communication and surveillance that would aid in the management of air traffic under the FANS infrastructure.

The FANS report was published in 1988, laying the basis for the industry's future strategy for the CNS/ATM concept; Air Traffic Management (ATM) through digital Communication, Navigation and Surveillance (CNS). Work then started on the development of the technical standards needed to realize the FANS concept.

The Boeing Company, reportedly seeking the cost saving benefit that FANS technology provides, announced the first implementation of FANS in the early 1990s, known as FANS-1. It used existing satellite-based ACARS communications, targeting operations in the South Pacific Oceanic region. The deployment of FANS-1 was to improve route choice available to operators, and thereby reduce fuel burn.

Later on, a similar product was developed by Airbus, a Boeing competitor. Today, the two technologies are collectively known as FANS-1/A. FANS today uses automatic position reporting and Controller Pilot Data Link Communications (CPDLC) directly to ATC over VHF using VDL Mode 2 or SatCom (Inmarsat or Iridium) in lieu of ACARS, to enable more efficient communications between the aircraft and ATC.

Improved Communications

The goal of FANS 1/A is to improve safety and performance related to Communication, Navigation and Surveillance (CNS) / Air Traffic Management (ATM) activities within the operating environment.

- HF traffic is reduced, clearing the channel
- Poor quality of HF is no longer an issue
- Standardized message set removes language barrier
- No impact from increased solar flares in 2013
- Lower stress on crew

Used with permission from the FAA

FANS in the North Atlantic Track System

ATC services are now provided to FANS-1/A equipped aircraft in other oceanic airspaces, and is widely used in the North Atlantic Track System (NATS).

The North Atlantic airspace utilizes a constantly changing 12 hour track system (NAT) designed around the high altitude winds and weather to optimize flights each day. Because there are over 1,400 aircraft crossing the North Atlantic each day (and growing), ATC needed a technology to increase airspace capacity on the North Atlantic Tracks and subsequently, providing a higher level of safety for all aircraft operating in that airspace.

Mandates for FANS 1/A began in 2013 for the most efficient tracks in the North Atlantic. In 2015, all of the NATS will require FANS 1/A technology at optimum altitudes, increasing to most of the North Atlantic airspace FL350 and above by 2017.

Operators not equipped for FANS 1/A operations will be excluded from airspace which requires it, increasing total trip distance, time, emissions and ultimately more money. The fact is that some business jets simply do not have the range to get across the Atlantic without operating on the NAT at optimum altitudes. Operating outside of those optimum altitude may mean not being able to make the trip.

FANS 1/A Benefits

Reduced Separation Between Aircraft

In non-FANS procedural aircraft separation, errors in navigation and potential errors in voice communication between the flight crew and ATC are considered when determining the necessary airspace separation between aircraft. Through a satellite data link, aircraft equipped with FANS can transmit Automatic Dependent Surveillance-Contract (ADS-C) reports with actual position and intent information at specified time intervals automatically. The position report is based on the accuracy of the GPS position sensing.

Digital data communication between the flight crew and the ATC drastically reduces the possibility of error, and allows reduced aircraft separations in airspace. Increased airspace capacity means a greater availability of desired routes for the aircraft operating within that airspace.

FANS Benefits

- Reduced separation between aircraft
- Data link communication
- No altitude loss when crossing tracks
- More direct routings

Data Link Communication

Data link over a satellite system significantly improves communication clarity between the pilot and ATC, resulting in overall improved safety. Satellite communication can reduce the response time for an aircraft requesting a flight plan change request to a new, optimum altitude to reduce fuel burn.

VHF Data Link

The VHF Data Link (VDL) is a means of sending information between aircraft and ground stations. The new VDL Mode 2 network, a high-speed and high-capacity digital communications network, provides roughly 20 times the message capacity than today's commonly used ACARS. Use of VDL Mode 2 tends to be more cost efficient than VHF and service providers are encouraging its users to transition to the VDL Mode 2 network.

No Altitude Loss When Crossing Tracks

To avoid potential conflict, an aircraft that is approaching crossing tracks must be separated by altitude from any traffic on another track. As a result, one of the two aircraft can be forced to operate as much as 4,000 feet below optimum altitude. However, if the ATC has timely surveillance data, including projected intent, and the aircraft is able to control its speed so that it reaches the crossing point at a given time, altitude separation would be required less frequently.

More Direct Routings

By 2015, even aircraft that would normally fly a random route across the Atlantic will not be allowed to transition through or fly above the North Atlantic Track System (NATS) if they are not equipped for FANS, resulting in less-than-optimal routing.

Worldwide Requirements and Mandates

North Atlantic Track System

The scheduled implementation for the NAT FANS 1/A mandate is to exclude the airspace above the tracks for non-equipped aircraft. Therefore, traffic in or above the tracks requiring FANS 1/A will require appropriate equipage.

North Atlantic FANS 1/A Mandates

Date	Mandate	Details
February 2013	Phase 1 FANS 1/A in the NATS	Two center (most desirable) tracks, FL360-FL390 inclusive (no exemptions)
January 2014	European Data Link (Link 2000+ Program) Services Implementing Rule (DLS IR) Exemption	Aircraft that are FANS equipped and have operational approval are exempt from the DLS IR mandate for the lifetime of the aircraft
2015	Reduced Lateral Separation Minimums (RLatSM) in NATS	Two center (most desirable) tracks will have a 1/2 track between them
2015	"Phase 2, Step 1" Expanded FANS 1/A Airspace (determined June 2013)	All Organized Track System (OTS) FL350-FL390 inclusive (no exemptions)
2017	"Phase 2, Step 2"	FANS 1/A required in all Minimum Navigation Performance Standards (MNPS) airspace FL350-FL390, inclusive
2020	"Phase 2, Step 3"	FANS 1/A required in all MNPS airspace FL290 and above

European Mandate: Link 2000+ Programme

Mandate for FANS 1/A in domestic European airspace has not been announced, however data link communications is a key element of the Single European Sky (SES) initiative and equipage for FANS via the Universal Avionics solution will enable compliance with European initiatives as well.

The European implementation of CPDLC in upper airspace is outlined in the SES Data Link Services Implementing Rule (DLS IR) legislation published in January 2009 (EC Reg. 29/2009). The IR requires all existing aircraft operating above FL285 in European airspace to be retrofitted for the Link 2000+ Programme by February 15, 2015.

The FANS 1/A CPDLC message set existing in Universal Avionics' UniLink UL-800/801 Communications Management Unit (CMU) is different than what is required for Link 2000+, and will not be usable in European airspace. An upcoming software upgrade to the CMU will include the Link 2000+ CPDLC message set and Context Management (CM) functions required to meet the upcoming EUROCONTROL Link 2000+ Programme mandate.

US Mandate

The FAA plans to start implementing FANS 1/A technologies in domestic airspace as early as 2015, where data link will be used for clearances over VHF Data link Mode 2 system that is about 10 times faster than the existing VHF network.

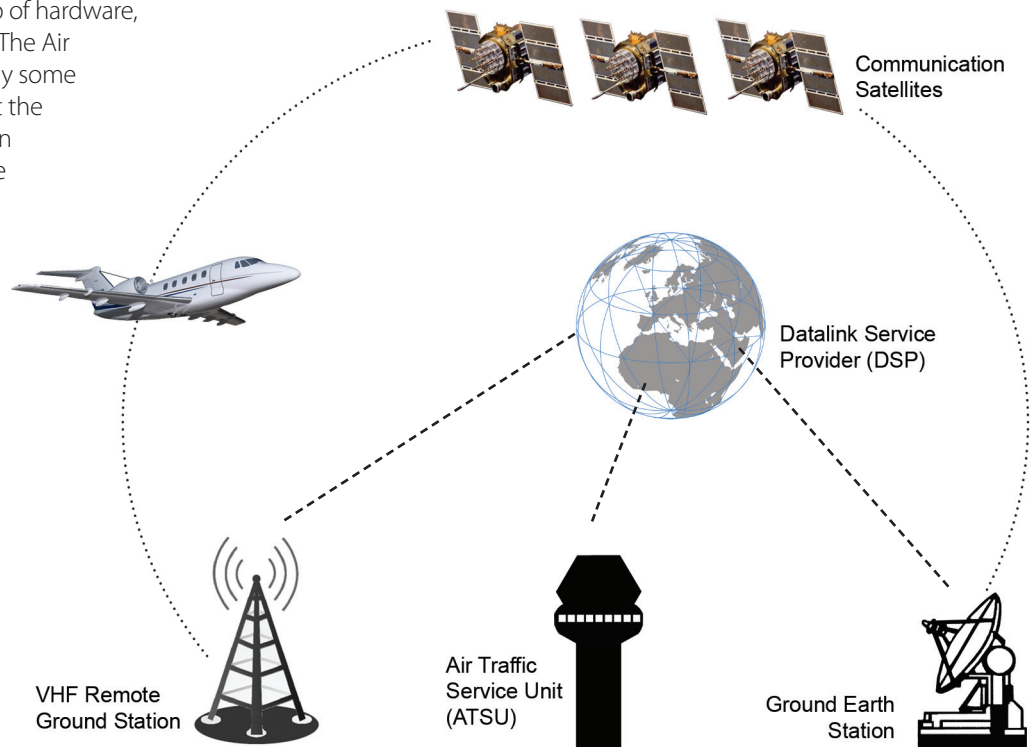
How the Data Link System is Connected

The data link system is made up of hardware, software and service providers. The Air Traffic Service Unit (ATSU) supply some of the system infrastructure, but the current data link system relies on the networks of Datalink Service Providers (DSP), such as SITA and ARINC, for the delivery of data link messages.

Also referred to as Communication Service Providers (CSP), the DSPs are commercial entities that offer similar services, but run their networks in different configurations.

FANS 1/A Technologies

Controller Pilot Data Link Communications



CPDLC is a method by which the ATC can communicate with pilots over a data link system, increasing the effective capacity and improving the availability of the communications channel. Data link permits the exchange of text-based messages between ATC ground systems and the aircraft. It is intended to supplement traditional voice over VHF and HF radio frequencies and free up voice radio channels.

CPDLC has two effective forms, a predefined message set and free text. The CPDLC message set provides a fixed set of responses to clearances, information, or request message elements which correspond to standard ATC voice phraseology. The controller is provided with the ability to issue standard instructions or requests for information. The pilot is provided with a standard set of responses to these instructions or requests. "Free Text" messages are used when information needs to be exchanged that is not conforming to these defined formats.

The technology is currently being deployed in European Airspace under the Link 2000+ Programme, but the defined message set is different than what is used for FANS airspace. A future software release for the UniLink UL-800/801 CMUs will include these message sets, allowing operators to comply with Link 2000+ Programme.

Automatic Dependent Surveillance-Contract

Automatic Dependent Surveillance-Contract (ADS-C) reports the current flight position via satellite or VHF data link to the ATC or to the airline's operational control center. It improves the surveillance of enroute aircraft. ADS-C requires a peer-to-peer relationship with a ground facility to acknowledge receipt of ADS-C messages. This capability is embedded within the Universal UniLink UL-800/801 CMU and is largely transparent to the flight crew.

Equipment Installation for FANS 1/A

Aircraft approval for FANS operations require a Letter of Authorization (LOA) from the FAA and equipment installation under a Supplemental Type Certificate (STC) or OEM Service Bulletin in accordance with AC 20-140B, to include:

- Flight Management System (FMS), i.e. Universal Avionics SBAS-FMS, Software Control Number (SCN) 1000.5/1100.5 or later
- Communications Management Unit (CMU), i.e. Universal Avionics UniLink UL-800 or UL-801
- Level 'D' SatCom system, i.e. Inmarsat or Iridium
- External annunciator "cube" or installation integrated into flight displays
- Aural Alert - a sonalert or some other means to provide a "Signature" aural advisory to alert the flight crew of incoming CPDLC messages
- Data Capable Cockpit Voice Recorder (CVR) (AC 20-160), i.e. Universal Avionics CVR/Flight Data Recorder (FDR)

SatCom Considerations

FANS 1/A data link operations in remote oceanic airspace are transmitted via SatCom or VDL Mode 2 if within range. Verify with the SatCom provider that it is an ARINC 741-compliant system.

Per AC 20-140B the SatCom TSO requirements are as follows:

- Inmarsat's SatCom (Inmarsat Data 2)-TSO-C132
- Iridium's SatCom (i.e. Short Burst Data, SBD)-TSO-C159a

Currently there are no SatCom systems on the market meeting these TSO requirements. The FAA has stated that an Alternate Means Of Compliance (AMOC) will be accepted for the short term for capable SatCom systems without TSO approval. Please contact Universal Avionics for the latest SatCom/UniLink compatible interfaces.

Obtaining FANS Operational Approval

Crew Training

In order for the operator to receive an LOA for FANS operations from the FAA, the flight crew must complete an applicable FAA approved training course. Contact Universal Avionics for a list of training providers.

AC 20-140B Considerations

Advisory Circular (AC) 20-140B, dated 9/27/12, "Guidelines for Design Approval of Aircraft Data Link Communication Systems Supporting Air Traffic Services (ATS)" provides one acceptable means of compliance, but not the only means, for type design approval of aircraft that have a data link system installed.

This AC provides airworthiness requirements for aircraft with an installed data link system intended to support air traffic services. It identifies specific configurations of aircraft data link systems for applicants seeking approval for STCs in order to facilitate operational approvals.

Summary

FANS has matured over the past three decades from an aircraft OEM cost saving feature to a necessity for effective worldwide airspace management and communication advancements. Several areas are mandating FANS capability and excluding non-equipped aircraft from airspaces with the most desirable and cost saving routes. Equipping for FANS operations can provide a return on investment for aircraft dependent upon operating in those airspaces, and provides substantial operator benefits.

Reference List

- FAA AC 20-140B, Guidelines for Design Approval of Aircraft Data Link Communication Systems Supporting Air Traffic Services (ATS)
- FAA AC 20-160, Onboard Recording of Controller Pilot Data Link Communication in Crash Survivable Memory
- FAA AC 120-70B, Operational Authorization Process for use of Data Link Communication System
- FAA AC 91-70A Oceanic and International Operations
- Global Operational Data Link Document (GOLD), 2nd Edition, 26 April 2013
- FAA TSO-C160, VDL Mode 2 Communications Equipment
- RTCA/DO-258A, Interoperability Requirements for ATS Applications Using ARINC 622 Data Communications (FANS 1/A Interoperability Standard)
- DO-306 Chg 1, Safety and Performance Standards for Air Traffic Data Link Services in Oceanic and Remote Airspace (Oceanic SPR Standard)
- ED-85A, Data Link Application System Document (DLASD) for the "Departure Clearance" Data-Link Service
- ED-89A, Data-Link Application System Document (DLASD) for the "ATIS" Data-Link Service
- ED-106A, Data-Link Application System Document (DLASD) for the "Oceanic Clearance Data-Link Service
- RTCA/DO-290, Safety and Performance Requirements Standard for Air Traffic Data Link Services in Continental Airspace (Continental SPR Standard)
- ED-154A, Future Air Navigation System 1/A - Aeronautical Telecommunication Network Interoperability Standard

Acronyms

- AC - Advisory Circular
- ADS-B - Automatic Dependent Surveillance-Broadcast
- ADS-C - Automatic Dependent Surveillance-Contract
- AMOC - Alternate Means of Compliance
- AFN - ATS Facilities Notification
- AOC - Airline Operational Control
- ACARS - Aircraft Communications Addressing and Reporting System
- ATC - Air Traffic Control
- ATM - Air Traffic Management
- ATN - Aeronautical Telecommunications Network
- ATS - Air Traffic Service
- CM - Context Management
- CMU - Communications Management Unit
- CNS - Communication, Navigation and Surveillance
- CPDLC - Controller Pilot Data Link Communications
- CSP - Communication Service Provider
- CVR - Cockpit Voice Recorder
- DLS IR - Data Link Services Implementing Rule
- DSP - Datalink Service Providers
- FANS - Future Air Navigation System
- FDR - Flight Data Recorder
- FMS - Flight Management System
- GPS - Global Positioning System
- HF - High Frequency
- ICAO - International Civil Aviation Organization
- LOA - Letter of Authorization
- MNPS - Minimum Navigation Performance Specification
- NATS - North Atlantic Track System
- OEM - Original Equipment Manufacturer
- OOOI - Out/Off/On/In
- OTS - Organized Track System
- RLatSM - Reduced Lateral Separation Minimum
- RLongSM - Reduced Longitudinal Separation Minimum
- SBAS - Satellite-Based Augmentation System
- SatCom - Satellite Communications
- SES - Single European Sky
- SCN - Software Control Number
- STC - Supplemental Type Certificate
- TC - Type Certificate
- VDL - VHF Datalink
- VHF - Very High Frequency

About Universal Avionics

Universal Avionics manufactures and markets an extensive line of advanced avionics equipment. Product lines include the UNS-1 SBAS-enabled (WAAS) Flight Management Systems; the EFI-890R/890H Flat Panel Display; a line of Integrated Cockpit Displays; Vision-1® Synthetic Vision System; Terrain Awareness and Warning System; UniLink® Communications Management Unit; Radio Control Units; Cockpit Voice and Flight Data Recorders; Attitude Heading Reference System (AHRS); and the Application Server Unit which integrates charts, electronic documents and checklists with displays systems. For more information about Universal Avionics, visit www.uasc.com.



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