

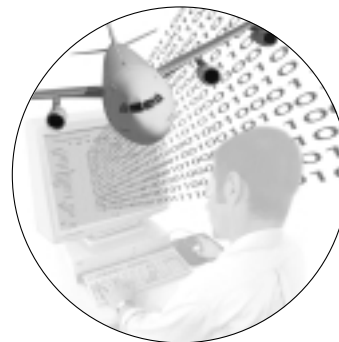


getting to grips with
datalink

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datalink

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AIRBUS

FOREWORD

The purpose of this document is to provide Airbus aircraft operators with basics on datalink systems and operations. All recommendations and guidance are intended to assist the operators in maximizing the cost-effectiveness of their operations.

Traditionally, aircraft communications are based on analog voice via VHF and HF radios, but since the mid-1980s the use of datalink-based communications has emerged. Aircraft can now be equipped to use communication technologies that transport data and make possible to communicate efficiently with the ground at all times during a flight, enabling the exchanges of constant up-to-date information that allows a better decision making.

This document assesses the links available for aircraft communications and depicts the applications that could be implemented by airlines to improve day-to-day aircraft operations. Each of these applications is related to benefits associated directly to efficiencies for the airline in aircraft performance and management as well as those of safety, as air traffic controllers must cater for more aircraft within their environments. The use of datalink in airspace management (CNS/ATM concept) is described in the brochure "Getting to grips with FANS" (reference: STL 945.7011/03). Whenever needed, the reader will be invited to refer to this document.

Moreover, wide range of new applications (such as Airbus Less Paper Cockpit) can benefit from datalink. Data loading and update could be achieved through datalink. Furthermore, aircraft communications are being expanded to support functions that were previously classified as navigation and surveillance, but these last are not part of this document as not impacting AOC operations.

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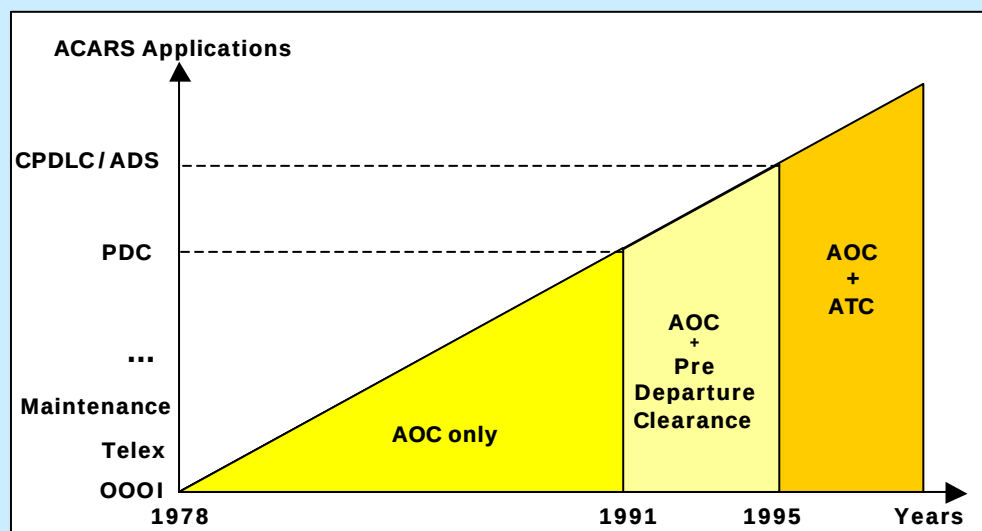
EXECUTIVE SUMMARY

Chapter 1: What is datalink?

- Datalink is the exchange of digitized information between end-users.
- There is independence between applications and datalink media.
- Aeronautical communications can be classified as follow:

- **AOC** (Airline Operational Communications)
- **AAC** (Airline Administrative Communications)
- **APC** (Airline Passenger Correspondence)
- **ATC** (Air Traffic Control communications)

Scope of this brochure



But ACARS has inherent limitations, which impair datalink network growth development and the implementation of CNS/ATM. Therefore, a new network called ATN (Aeronautical Telecommunication Network) is being developed.

Chapter 2: Datalink components description

The main elements of air/ground datalink are:

- **Communication Media or “Pipes”**

Based on VHF, Satellite, HF or even ModeS, they provide the connection between airborne and ground end-systems operated by the Datalink Service Providers (DSP).

- **Airlines’ ground processing systems**

The ground processing system gathers in real-time all datalink traffic to/from the airline, providing the interface between the service provider and the airline operation center. A core server routes and formats messages to back-end computer systems in the airline, such as: operations control systems, weight and balance calculations and takeoff performance calculation computers.

- **Datalink Service Providers (DSPs)**

They are responsible for the reliability of the “pipes” and the integrity of the exchanged messages. They ensure continuous coverage on a global scale, by using a variety of Air/Ground datalinks as well as operations centers and terrestrial Ground-Ground networks.

- **Applications**

Enabled by datalink communications, they produce the beneficial outcomes for the aircraft operators and the ATC.

The core of the airborne datalink system is called ACARS router. It routes received messages from the ground to appropriate end-systems on-board the aircraft, such as Flight Management Computer, Aircraft Condition Monitoring System (ACMS), Cabin terminal ...

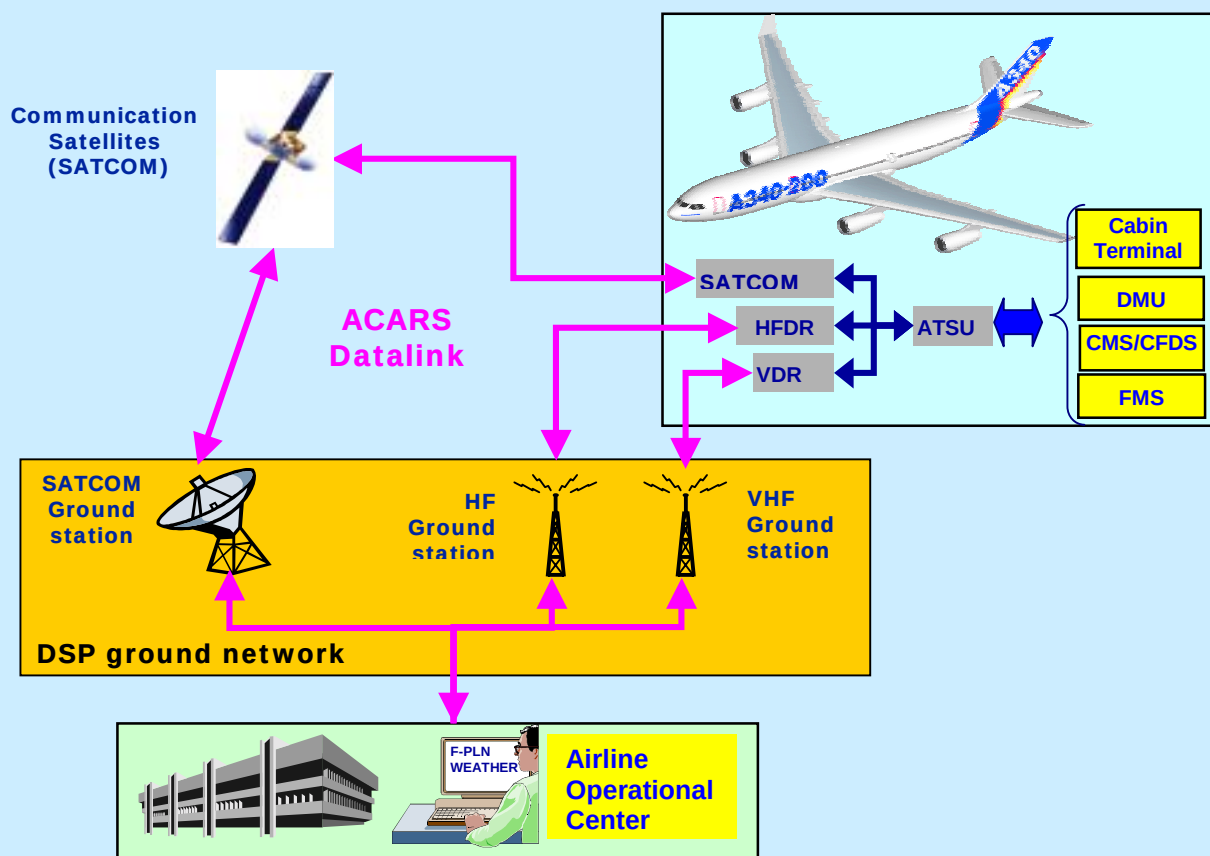
The avionics unit, called Air Traffic Service Unit (ATSU), has been developed to cope with datalink communications and embeds the ACARS router.

Chapter 2: Datalink components description (continued)

Two types of airborne datalink applications exist, internal or external to the ATSU:

- **ATSU Hosted applications:** AOC and ATC
- **ATSU Remote AOC applications** in ATSU peripherals: FMS, DMU, CMS/CFDS and Cabin Terminal.

Hosted AOC applications can be fully customized whereas remote AOCs customization is done through settings.



Chapter 3: Airborne applications software description

- **ATSU Hosted AOC applications**
 - AOC software
 - o Standard (Honeywell or Rockwell-Collins), or
 - o Full customization possible (within Airbus defined perimeter)
 - ATC software – not customizable
- **ATSU Remote AOC applications**
 - **Operation principles**
 - o Manual command (through MCDU)
 - o Automatic mode (pre-programmed triggering conditions)
 - o Uplink request (from ground, transparent to the crew)
 - **DMU**

DMU provide the capability to transmit reports to the ground to achieve:

 - o *Aircraft performance* monitoring
 - o *Engine condition* monitoring
 - o *APU health* monitoring
 - **CMS/CFDS**

CMS/CFDS provide the capability to transmit maintenance reports to the ground concerning:

 - o In-flight and Post Flight Reports
 - o Real-Time Failure & Warning
 - o Other miscellaneous maintenance reports
 - **FMS**

The FMS-AOC datalink allows data exchange over the ACARS network between the aircraft's FMS and the ground AOC of the following:

 - o Flight plan initialization
 - o Takeoff data
 - o Wind data
 - o Aircraft performance data
 - o Reports: position, progress, flight plan, performance
 - **Cabin Terminals applications**

The ATSU transmits uplink messages from ground to the Cabin Terminals and sends to the ground downlink messages, without processing the data contained in these messages

For instance, the PFIS (Passenger Flight Information System) can be connected to the ATSU to display information such as the gates for connecting flights...
- **Prospective applications**

Emerging technologies based on IP (Internet Protocol), such as Satcom Swift64 or HSD (High Speed Data) services, or even Gatelink, provide a high data rate (30 to 500 times greater than ACARS).

Note: avionics applications cannot use these transmission means, but crew and passengers can benefits from them (e.g. weather map update).

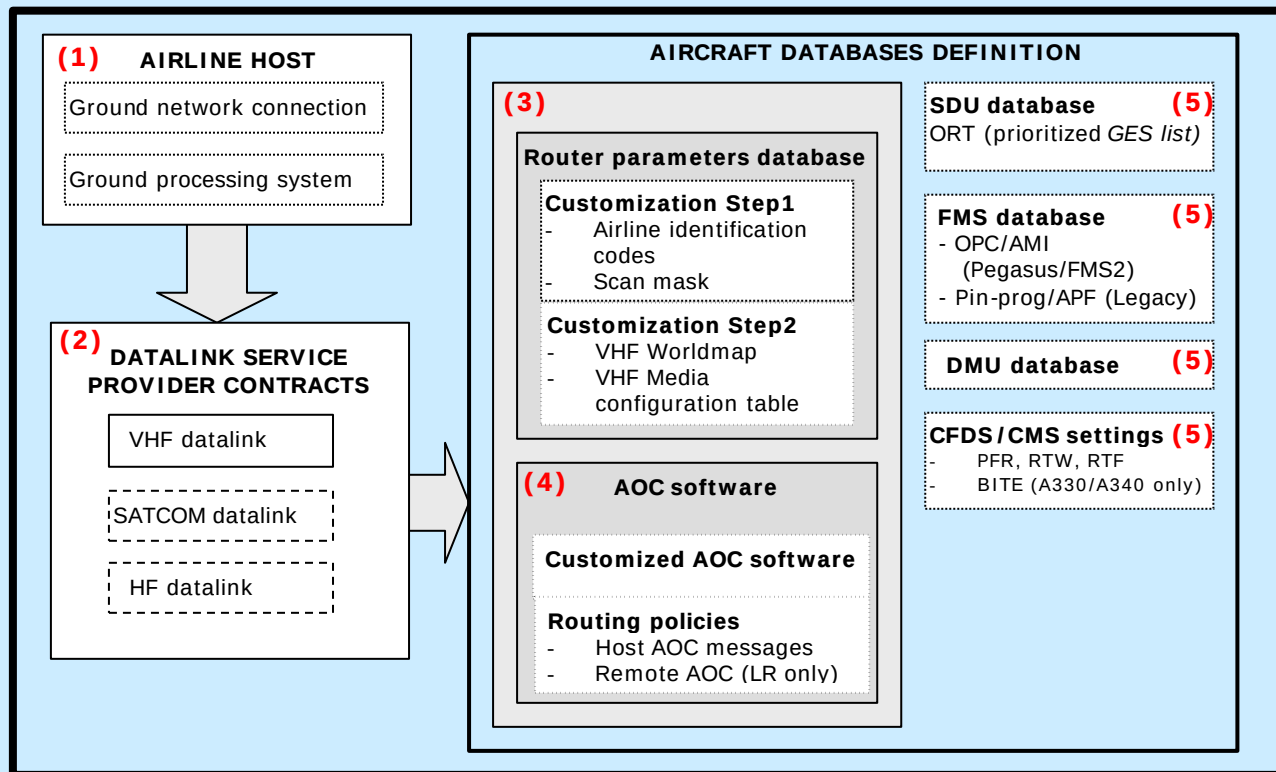
Chapter 4: Operational use of datalink

- The **mains actors** involved in the aircraft operation process, aside the crew, are the following:
 - Airline Flight Operations
 - Airline Crew Management
 - Maintenance
 - Ground handling
 - Catering services
 - Fuelling services
 - Cleaning services
 - Passenger assistance
 - ATC Centers (Air Traffic Control Centers)
- **Basic Datalink applications**
 The firsts applications usually implemented by airlines when starting datalink operations are:
 - OOOI (Out-Off-On-In)
 - Weather
 - Free text telex
 - Maintenance
- **Datalink applications per end-users**
 Each end-user utilizes a set of dedicated applications.
 - Flight operations:
 Flight preparation files update, Takeoff data, Loadsheet, WPR, FOB, ETA...
 - Maintenance:
 MEL advisory, DMU & CMS/CFDS reports, snag & customized reports...
 - Crew management:
 Delay or Diversion management, pay computation, records and statistics...
 - Cabin crew:
 Pax info, technical reports, catering management, station assistance...
 - Ground handling:
 In-range/approach reports, arrival info, PIL, boarding status...
 - Passengers:
 Destination information, connecting flights, re-booking info...
 - Miscellaneous:
 Fueller (fuel request, receipt...), De/Anti-icing (request, location, receipt...)
 - ATC:
 D-ATIS, Clearances (pre-departure/departure, oceanic...), CPDLC/ADS...

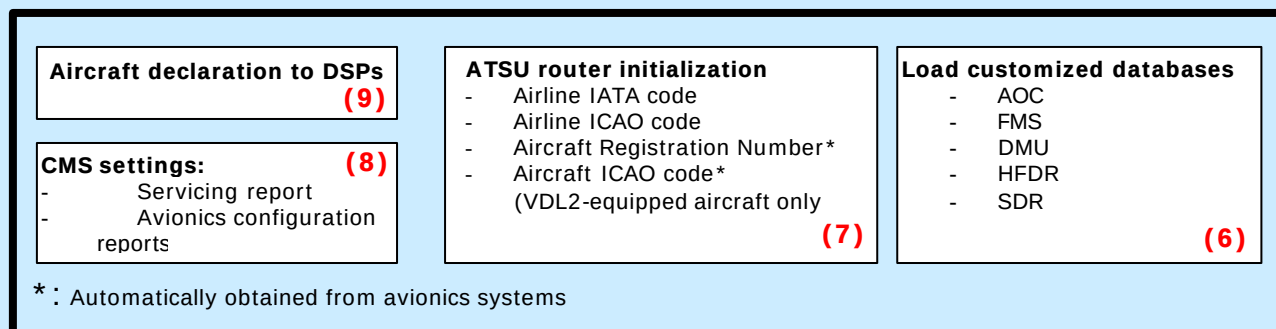
Chapter 5: Starting AOC datalink operations

Contracts, connections and databases definition

Work to be done by the airline for the whole datalink-equipped aircraft fleet



Work to be repeated for each datalink-equipped aircraft entry into service or datalink retrofitted



Chapter 5: Starting AOC datalink operations

- (1)** – Establish an airline host *terminal connection* to interface DSP ground network with airline ground processing tools.
- (2)** – *Sign contracts* with Datalink Service Provider(s) and *declare* datalink-equipped aircraft.

Databases definition

- (3)** – Define the different router parameters database
 - Step 1: *Airline codes* (IATA and ICAO) along with the *VHF Scanmask* must be set to insure proper routing of messages.
 - Step 2: *VHF World map* should be defined in accordance to airline DSP strategic routing policy.
- (4)** – In case a *customized AOC* is intended to be installed, it must be specified to Honeywell or Rockwell at this step.
- (5)** – Define the Ground Earth Stations/Satellites on which the aircraft will logon in the *SDU Owner Requirements Table (ORT)*.
- (5)** – The *FMS files/databases* have to be defined to activate the FMS datalink capability. This is achieved through:
 - OPC file & AMI Database for Pegasus Honeywell / Thales FMS
 - Pin-prog & APF for Legacy Honeywell
- (5)** – To enable the automatic downlink of DMU reports, the *DMU database* must be programmed accordingly.
- (5)** – The *activation of CFDS / CMS reports* functions is programmed in the ATSU (for permanent settings) and in the AOC database or through the MCDU menu for temporary settings.

ATSU initialization and database loading

- (6)** – The customized AMI or APF, AOC, DMU and ORT databases must be loaded into the FMS, the ATSU, the DMU and the SDU respectively.
- (7)** – The ATSU router initialization step consists in the definition of parameters such as: IATA and ICAO airline codes, ICAO aircraft ID (for VDL2-equipped aircraft only), Aircraft Registration Number.
- (8)** – Complementary settings can be achieved manually on the CFDS / CMS through dedicated MCDU pages.
- (9)** – Newly delivered aircraft tail number must be declared to the contracted Datalink Service Provider(s) in order to be clearly identified in DSP tables.

Chapter 6: Datalink communication subnetworks

- **VHF datalinks (VDL)**

VHF datalinks are the “pipes” most commonly used in civil aviation, because they are economical to implement and they provide excellent operational performance. However, VHF is limited to line-of-sight coverage (nominal range of about 240 NM at 30,000ft).

Low-speed VHF is the basic pipe used for ACARS, but which has also been used for ATS since 1991, in accordance with ARINC (protocol) specifications 618, 620, 622 (bit-oriented) and 623 (character-oriented). ICAO has not developed SARPs for the low-speed VHF.

VDL mode 2

- VDL2 is an air/ground datalink, nominally operating at 31.5kbps.
- With its much higher data rate (31.5 Kbps as opposed to 2.4 Kbps of low-speed VHF), it was chosen by the industry to resolve the problem of ACARS reaching near saturation, especially over Europe.
- The minimal (initial) version of VDL 2 is called ACARS Over AVLC (AOA) and is used by airlines for AOC.
- VDL 2/AOA aims at delivering a higher message throughput (allowing an 8 to 1 reduction in VHF frequency usage) i.e. the VDL 2 transmission (new aircraft VDRs and VDL 2 ground stations) replaces the low-speed VHF, but other ACARS elements remain unchanged.
- ICAO has developed SARPs for VDL mode 2.

- **High Frequency Datalink (HFDL)**

- HFDL is the only available datalink for polar routes also deployed over remote regions.
- It has a low data rate, is shared among many users, but does support FANS A and ACARS applications.
- It is currently providing complete coverage over the northern polar region, but with a message transit time of about 80 seconds is slower than satellite.
- HF is included in the ICAO SARPs.

- **Aeronautical Mobile Satellite Service (AMSS)**

- AMSS is operated by Inmarsat, providing narrowband services to aircraft
- First operations for AOC in 1990
- It was certified for ATS use in 1992.
- Existing satellite coverage is global, with the exception of Polar Regions, north and south of about 80 degrees of latitude.

- **Gatelink**

- Gatelink has been specified by the aeronautical industry (AEEC 763) to provide **high-speed wireless communications** between an aircraft and a network on the ground at an airport terminal or at a maintenance position.
- This IP-based network remains transparent to customer applications and allows an access to worldwide DSPs' ground networks.
- The typical coverage is a cell around the access point (around 300m).

Chapter 7: ATN overview

- ATN is a data communications internetwork that provides a common communications service for all ATC and AOC.
- The ATN Internet is made up the following functional components:
 - *End Systems* (provide the end-user applications)
 - *Intermediate Systems* (routers)
 - *Ground-Ground communication subnetworks*
 - *Air-Ground communication subnetworks*

The Internet approach was seen as the most suitable approach for ATN
At the beginning, ATN will be introduced only for ATC communications.
- ATN programs and operations
 - The Link 2000+ program is the initial operational implementation of ATN in Europe up to 2007.
 - ATN is currently operated at the Miami ACC but the initial project schedule has been postponed and the deployment to the whole territory has been reschedule after 2010.
- Datalink operations **convergence** will enable mixed fleets (ACARS datalink & ATN datalink-equipped aircraft) to operate with both ATN or ACARS ATC centers.

ABBREVIATIONS

- A -

A/G	Air/Ground
AAC	Aeronautical Administrative Communications
AAIM	Aircraft Autonomous Integrity Monitoring
ABAS	Airborne Based Augmentation System
ACARS	Aircraft Communications Addressing and Reporting System
ACAS	Airborne Collision Avoidance System
ACC	Area Control Center
ACMS	Aircraft Condition Monitoring System
ADLP	Aircraft Data Link Processor
ADS	Automatic Dependent Surveillance
ADS-B	Automatic Dependent Surveillance - Broadcast
ADSP	Automatic Dependent Surveillance Panel
AFTN	Aeronautical Fixed Telecommunications Network
AIDC	ATS Interfacility Data Communication
AIDS	Aircraft Instrument Data System
AIP	Aeronautical Information Publication
AIS	Aeronautical Information Service
AMCP	Aeronautical Mobile Communication Panel
AMHS	Aeronautical Message Handling System
AMSS	Aeronautical Mobile Satellite Service
AOA	ACARS Over AVLC
AOC	Aeronautical Operational Control
AOG	Aircraft On Ground
APC	Aeronautical Passenger Communications
APP	Approach
ARINC	Aeronautical Radio Inc.
ARTAS	ATS Radar Tracker and Server
ASEs	Application Service Elements
ASM	Airspace Management
ASPP	Aeronautical Fixed Service and System Planning Panel
ATC	Air Traffic Control
ATFM	Air Traffic Flow Management
ATIS	Automatic Terminal Information Service
ATM	Air Traffic Management
ATM	Asynchronous Transfer Mode
ATN	Aeronautical Telecommunication Network
ATNP	ATN Panel
ATNSI	ATN Systems Inc.
ATS	Air Traffic Services
ATSC	Air Traffic Services Communications
ATSU	Air Traffic Service Unit
AVLC	Aviation VHF Link Control

- B -

BITE	Built-In Test Equipment
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- C -

CAA	Civil Aviation Authority
CBA	Cost Benefit Analysis
CCITT	Comité Consultatif International Télégraphique et Téléphonique
CDTI	Cockpit Display of Traffic Information
CFDIU	Centralized Fault Data Interface Unit
CFDS	Centralized Fault Data System
CIDIN	Common ICAO Data Interchange Network
CLNP	Connectionless Network Protocol
CLNS	Connectionless Network Service
CLTP	Connectionless Transport Protocol
CM	Context Management
CMC	Central Maintenance Computer
CMS	Central Maintenance System
CNS	Communications, Navigation and Surveillance
CNS/ATM-1	CNS/ATM Package 1
COTP	Connection Oriented Transport Protocol
COTS	Connection-Oriented Transport Service
CPDLC	Controller-Pilot Data Link Communications
CPT	CaPTain
CSMA	Carrier Sense Multiple Access
CT	Cabin Terminal

- D -

DCDU	Data Communication Display Unit
DCL	Departure Clearance
D8PSK	Differentially encoded 8-Phase Shift Keying
DME	Distance Measuring Equipment
DMU	Data Management Unit
DOW	Dry Operating Weight
DSP	Datalink Service Provider

- E -

EATMS	European Air Traffic Management System
ECAC	European Civil Aviation Conference
ECAM	Electronic Centralized Aircraft Monitoring
EGNOS	European Geostationary Navigation Overlay System
EOLIA	European preOperational dataLink Applications
ES	End System
ETA	Estimated Time of Arrival
ETD	Estimated Time of Departure
EUR	Europe

- F -

FAA	Federal Aviation Administration
FANS	Future Air Navigation System
FDMA	Frequency Division Multiple Access
FIR	Flight Information Region
FIS	Flight Information Services
FL	Flight Level
FLT	Flight
FMGC	Flight Management and Guidance Computer
FMGEC	Flight Management and Guidance and Envelope Computer

FMS	Flight Management System
F/O	First Officer
FOB	Fuel On Board
FPL	Filed Flight Plan
- G -	
GBAS	Ground Based Augmentation System
GDLP	Ground Data Link Processor
GES	Ground Earth Station
G/G	Ground- Ground
GICB	Ground Initiated Comm-B
GLONASS	Global'naya Navigatsionnaya Sputnikovaya Sistema
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
- H -	
HF	High Frequency (3-30MHz)
HFDR	HF Data Radio
HMI	Human Machine Interface
- I -	
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
ICC	Inter-Center Co-ordination
IDRP	Inter-Domain Routing Protocol
IEEE	Institute of Electrical and Electronics Engineers
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMI	Imbedded Element Identifiers
INS	Inertial Navigation System
IOC	Input/Output Calls
IP	Internet Protocol
IRS	Inertial Reference System
IS	Intermediate System
ISDN	Integrated Services Digital Network
ISO	International Standards Organization
ITU	International Telecommunications Union
- J -	
JAA	Joint Aviation Authorities
- K -	
Kbps	Kilo Bit Per Second
- L -	
LAAS	Local Area Augmentation System
LAN	Local Area Network
LEOs	Low Earth Orbit Satellites
LW	Landing Weight
- M -	
MAC	Media Access Control
MAN	Metropolitan Area Network
MCDU	Multifunction Control Display Unit

MEL	Minimum Equipment List
MEOs	Medium Earth Orbit Satellites
MET	Meteorological
METAR	Meteorological Aerodrome Report
MHS	Message Handling System
MLS	Microwave Landing System
MMR	Multi-Mode Receiver
MNPS	Minimum Navigation Performance Specification
MSAS	Multi Purpose Satellite Based Augmentation System
MTSAT	Multi Purpose Transport Satellite
MWO	Meteorological Watch Offices
Mode S SSR	Mode S Secondary Surveillance Radar

- N -

NAS	National Airspace System
NAT	North Atlantic
NAV	Navigation
NDB	Non Directional Beacon
NM	Nautical Mile
NOTAM	Notice to Airmen
NOTOC	NOTice TO Captain
NPV	Net Present Value
NSAP	Network Service Access Point

- O -

OAT	Outside Air Temperature
OCC	Operations Control Center
OCL	Oceanic Clearance
OOOI	Out Off On In
OPMET	Operational Meteorological Traffic
OSI	Open Systems Interconnection

- P -

PAC	Pacific
PANS	Procedures for Air Navigation Services
PAX	Passenger
PDC	Pre Departure Clearance
PDU	Protocol Data Unit
PETAL	Preliminary Eurocontrol Test of Air/ground data Link
PIRG	Planning and Implementation Regional Group
PSR	Primary Surveillance Radar

- Q -

QoS	Quality of Service
-----	--------------------

- R -

RAF	Reference ATN Facility
RAIM	Receiver Autonomous Integrity Monitoring
RCP	Required Communications Performance
RD	Routing Domain
RDT	Research, Development and Test
REQ	REQuest
RF	Radio Frequency
RFC	Request for Change

RNAV	Area Navigation
RNP	Required Navigation Performance
RTCA	Radio Technical Commission for Aeronautics
RVR	Runway Visibility Range
RVSM	Reduced Vertical Separation Minima
RWY	Runway
- S -	
SARPS	Standards and Recommended Practices
SBAS	Space Based Augmentation System
SDR	Satellite Data Radio
SIGMET	Significant Meteorological Effects
SIGWX	Significant Weather
SIR	Serveur d'Informations Radar
SLM	Standard Length Message
SMGCS	Surface Movement Guidance and Control System
SSR	Secondary Surveillance Radar
STDMA	Self-Organizing Time Division Multiple Access
- T -	
TAF	Terminal Area Forecast
TAR	Trials ATN Router
TCAS	Traffic Alert/Collision Avoidance System
TDMA	Time Division Multiple Access
TDWR	Terminal Doppler Weather Radar
TFM	Traffic Flow Management
TIS	Terminal Information Services
TIS	Traffic Information Service
TMA	Terminal Maneuvering Area
TODC	Take Off Data Calculation
TOW	Take Off Weight
- U -	
UDP	User Datagram Protocol
ULA	Upper Layer Architecture
USA	United States of America
UTC	Universal Coordinated Time
- V -	
VDL	VHF Digital Link
VFR	Visual Flight Rules
VHF	Very High Frequency (30 - 300 MHz)
VMC	Visual Meteorological Conditions
VOLMET	Meteorological Information for Aircraft in Flight
VOR	VHF Omni-directional Radio Range
- W -	
WAAS	Wide Area Augmentation System (US)
WLAN	Wireless Local Area Network
Wx	Weather
- Z -	
ZFW	Zero Fuel Weight

TERMINOLOGY, ACRONYMS AND GLOSSARY OF TERMS

This part contains general definitions relevant to communication systems. Definitions specific to each of the systems included in this volume are contained in the relevant chapters.

Accuracy is the degree of conformance between the measured or estimated position and the true position of an aircraft at a given time.

Aeronautical telecommunication network (ATN): An internetwork architecture that allows ground, air-ground and avionic data subnetworks to interoperate by adopting common interface services and protocols based on the International Organization for Standardization (ISO) Open Systems Interconnection (OSI) reference model.

Aircraft address: A unique combination of twenty-four bits available for assignment to an aircraft for the purpose of air-ground communications, navigation and surveillance.

Aircraft earth station (AES): A mobile earth station in the aeronautical mobile-satellite service located on board an aircraft (see also "GES").

ARINC Specifications (developed in Appendix E):

ARINC 618: Air/ground character-oriented protocol specification

ARINC 619: ACARS protocols for avionic end systems

ARINC 620: Datalink ground system standard and interface specification

ARINC 622: ATS over ACARS

ARINC 623: Character-oriented air traffic service (ATS) applications

ARINC 631: VHF digital link implementation provisions Functional Description

ARINC 632: Gate-Aircraft Terminal Environment Link (Gatelink) Ground Side

ARINC 634: HF Data Link System Design Guidance Material

ARINC 635-4: HF Data Link Protocols

ARINC 637: Aeronautical telecommunications network implementation provisions

ARINC 716: Airborne VHF communications transceiver

ARINC 719-5: Airborne HF/SSB System

ARINC 724b: Aircraft communications addressing and reporting system (ACARS)

ARINC 741: Aviation Satellite Communication System

ARINC 750: VHF data radio

ARINC 751: Gate-Aircraft Terminal Environment Link (Gatelink) - Aircraft Side

ARINC 753-3: HF Data Link System

ARINC 758: Communications management unit (CMU)

Availability is the fraction of time that the services of the system are usable by the flight crew.

Bit oriented protocols treat the data as a continuous stream of bits, not as characters. They are transparent to the type of data. Data is still normally stored or transmitted in groups of eight bits, which strictly speaking should be called octets. Bit oriented protocols are far more efficient than Character oriented ones.

Character Oriented

The original systems were concerned with the transmission of text or printable data and generally used the ASCII alphabet in which only seven bits are used to describe a character. These seven bits are normally expanded to eight bits for data storage and transmission, the eight bit being the parity bit, providing limited error checking.

Continuity is the probability that a system will perform its function within defined performance limits for a specified period of time given the system is operating within the defined performance limits at the beginning of the flight operation.

CRC: (Cyclic Redundancy Check) The CRC is a very powerful but easily implemented technique to obtain data reliability. Using this technique, the transmitter appends an extra n- bit sequence to every frame (block of data) called Frame Check Sequence (FCS). The FCS holds redundant information about the frame that helps the transmitter detect errors in the frame. The CRC is one of the most used techniques for error detection in data communications.

DO-178B defines the guidelines for development of aviation software.

The verification of such software as per DO-178B standards depends on the level of criticality of the software. Software level is based upon the contribution of software to potential failure conditions as determined by the system safety assessment process. The software level definitions are:

a. Level A: Software whose anomalous behavior, as shown by the system safety assessment process, would cause or contribute to a failure of system function resulting in a **catastrophic failure** condition for the aircraft.

b. Level B: Software whose anomalous behavior, as shown by the system safety assessment process, would cause or contribute to a failure of system function resulting in a **hazardous/severe-major failure** condition for the aircraft. For example software whose failure conditions would reduce the capability of the aircraft or the ability of the crew to cope with adverse operating conditions to the extent that there would be physical distress or higher workload such that the flight crew could not be relied on to perform their tasks accurately or completely.

c. Level C: Software whose anomalous behavior, as shown by the system safety assessment process, would cause or contribute to a failure of system function resulting in a **major failure condition** for the aircraft. For example software whose failure conditions would reduce the capability of the aircraft or the ability of the crew to cope with adverse operating conditions to the extent that there would be a significant increase in crew workload.

d. Level D: Software whose anomalous behavior, as shown by the system safety assessment process, would cause or contribute to a failure of system function resulting in a **minor failure condition** for the aircraft. For example software whose failure conditions would cause slight increase in crew workload, such as, routine flight plan changes, or some inconvenience to occupants.

e. Level E: Software whose anomalous behavior, as shown by the system safety assessment process, would cause or contribute to **a failure** of system function with no effect on aircraft operational capability or pilot workload.

DSSS: Direct-Sequence Spread Spectrum is one of two types of spread spectrum radio, the other being Frequency-Hopping Spread Spectrum. DSSS is a transmission technology used in WLAN transmissions where a data signal at the sending aircraft is combined with a higher data rate bit sequence, or chipping code, that divides the user data according to a spreading ratio. The chipping code is a redundant bit pattern for each bit that is transmitted, which *increases the signal's resistance to interference*. If one or more bits in the pattern are damaged during transmission, the original data can be recovered due to the redundancy of the transmission

End-to-end: Pertaining or relating to an entire communication path, typically from the interface between the information source and the communication system at the transmitting end to the interface between the communication system and the information user or processor or application at the receiving end.

End-user: An ultimate source and/or consumer of information.

FHSS: Frequency-Hopping Spread Spectrum is one of two types of spread spectrum radio, the other being Direct-Sequence Spread Spectrum. FHSS is a transmission technology used in WLAN transmissions where the data signal is modulated with a narrowband carrier signal that "hops" in a random but predictable sequence from frequency to frequency as a function of time over a wide band of frequencies. The signal energy is spread in time domain rather than chopping each bit into small pieces in the frequency domain. *This technique reduces interference* because a signal from a narrowband system will only affect the spread spectrum signal if both are transmitting at the same frequency at the same time.

Ground earth station (GES): An earth station in the fixed satellite service, or, in some cases, in the aeronautical mobile-satellite service, located at a specified fixed point on land to provide a feeder link for the aeronautical mobile- satellite service.

The **IEEE 802** LAN/MAN Standards Committee develops Local Area Network standards and Metropolitan Area Network standards. The most widely used standards are for the Ethernet family, Token Ring, Wireless LAN, Bridging and Virtual Bridged LANs. An individual Working Group provides the focus for each area.

The **Industrial, Scientific and Medical (ISM)** radio bands were originally reserved internationally for non-commercial use of RF electromagnetic fields for industrial, scientific and medical purposes.

Individual countries' use of the bands designated in these sections may differ due to variations in national radio regulations.

In recent years they have also been used for license-free error-tolerant communications applications such as wireless LANs and Bluetooth:

- 900 MHz band (33.3 cm)
- 2.45 GHz band (12.2 cm)

Integrity is the ability of a system to provide timely warnings to users when the system should not be used for navigation.

ISO 8208: International Organization for Standardization X.25 Packet Level Protocol for Data Terminal Equipment Document

Mode S subnetwork: A means of performing an interchange of digital data through the use of secondary surveillance radar (SSR); Mode S interrogators and transponders in accordance with defined protocols.

OFDM: Orthogonal Frequency Division Multiplexing is a modulation technique for transmitting large amounts of digital data over a radio wave. OFDM works by splitting the radio signal into multiple smaller sub-signals that are then transmitted simultaneously at different frequencies to the receiver. OFDM reduces the amount of cross talk in signal transmissions.

Packet: The basic unit of data transfer among communications devices within the network layer.

Packet layer protocol (PLP):

A protocol to establish and maintain a connection between peer level entities at the network layer, and to transfer data packets between them.

Point-to-point: Pertaining or relating to the interconnection of two devices, particularly end-user instruments. A communication path of service intended to connect two discrete end-users; as distinguished from broadcast or multipoint service.

Slotted Aloha: A random access strategy whereby multiple users access the same communications channel independently, but each communication must be confined to a fixed time slot. The same timing slot structure is known to all users, but there is no other co-ordination between the users.

Time division multiplex (TDM): A channel sharing strategy in which packets of information from the same source but with different destinations are sequenced in time on the same channel.

Time division multiple access (TDMA): A multiple access scheme based on time-shared use of a channel employing:

- Discrete contiguous time slots as the fundamental shared resource; and,
- A set of operating protocols that allows users to interact with a master control station to access to the channel.

Transit delay: In packet data systems, the elapsed time between a request to transmit an assembled data packet and an indication at the receiving end that the corresponding packet has been received and is ready to be used or forwarded.

U-NII stands for the Unlicensed National Information Infrastructure. The FCC (Federal Communication Commission) has made available 300 MHz of spectrum for the U-NII devices that will provide short-range, high speed wireless digital communications. These new devices, which do not require licensing, will support the creation of new wireless local area networks (LANs) and facilitate access to the information highway. The U-NII spectrum is located at 5.15-5.35 GHz and 5.725-5.825 GHz.

VHF digital link (VDL): A constituent mobile subnetwork of the aeronautical telecommunication network, operating in the aeronautical mobile VHF frequency band.

X.25 Packet Switched networks allow remote devices to communicate with each other over private digital links without the expense of individual leased lines. Packet Switching is a technique whereby the network routes individual packets of data between different destinations based on addressing within each packet. An X.25 network consists of a network of interconnected nodes to which user equipment can connect.



1. WHAT IS DATALINK?

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1.1. DATALINK COMMUNICATION CHAIN

Datalink is the actual connection between either an end-system on-board one aircraft and an end-system located on the ground or on-board another aircraft, or both. The datalink is the communications media (or pipe) that transfers the message content between the applications that are operated in the end-systems. The end systems and the applications use the datalink to exchange information.

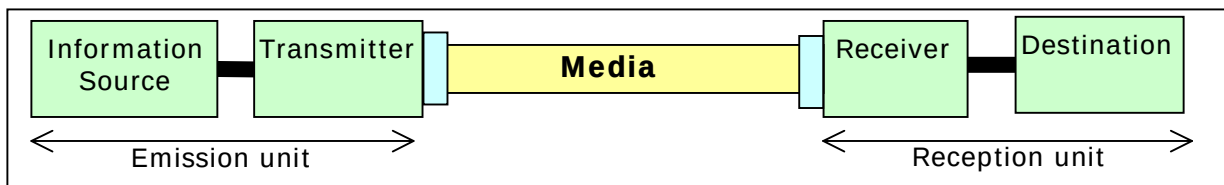


Figure 1.1
Communication chain

Datalink has many different forms (Air/Ground, Air/Air, and Ground/Ground), different protocols, applications (addressable, broadcast), and utilizes different communications media (VHF, HF, Satellite...).

The **main objectives** of datalink are to:

- Provide an alternative means of communication to voice;
- Automate as much as possible communications tasks;
- Reduce both the controller and pilot workload;
- Increase ATM efficiency, capacity, and safety;
- Provide additional information exchanges by utilizing airborne and ground automated systems capabilities.
- Provide surveillance in areas that are unsuitable for radar coverage

Datalink is a generic term for a communications technique, which enables the exchange of digitized information between end-users (sources and/or consumers of information). **The end-systems and the applications are independent of the datalink media used.**

1.2. DATALINK IN AERONAUTICS

1.2.1. BASICS ON AERONAUTICAL COMMUNICATIONS

Three major aeronautical datalink communication categories can be listed, differentiated by the end system:

- Air Traffic Services communications, between aircraft and ATC centers
- Airlines Datalink Communications (AOC & AAC)
- Aeronautical Passenger communications (APC)

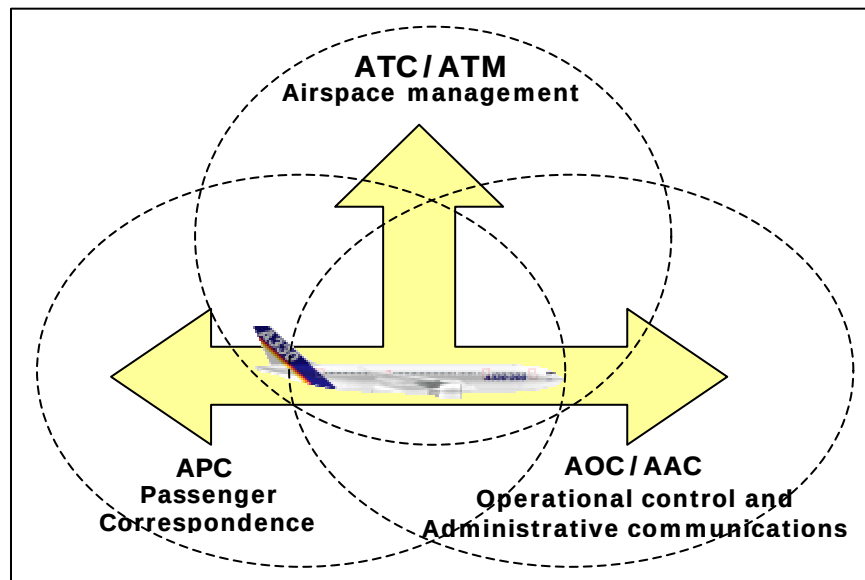


Figure 1.2: Aeronautical communication breakdown structure

Airline Operational Control (AOC) communications involve data transfer between the aircraft and the Airline Operational Center or operational staff at the airport associated with the safety and regularity of flights. This is considered to be a growth area and airlines are expected to start making increased use of datalink applications to provide communications at the gate and airborne monitoring applications.

Example: NOTAMS, Weather, Flight status, etc.

Airline Administrative Communications (AAC): include applications concerned with administrative aspects of airline business such as crew rostering and cabin provisioning. These are essential to the airlines business but do not impact the flight operation. AAC applications are not specified by ICAO and should not use communications resources reserved for safety communications.

Example: Passenger lists, Catering, Baggage handling, etc...

Airline Passenger Correspondence (APC): includes communications services that are offered to passengers (email, internet access and telephony). Access to such services would be via seatback screens, airline provided equipment or passengers own laptops or other mobile equipment. Services would be offered to passengers within the ticket price or as a chargeable service.

Example: Email, Internet, Live TV, Telephony, etc.

The term "AOC communication" used in the rest of the document designate, by extension, not only airline operational control communications, but also any kind applications dedicated to airlines (AOC, AAC and APC).

1.2.2. HISTORICAL BACKGROUND

1.2.2.1. USE OF DATALINK THROUGH 19TH / 20TH CENTURIES

In 1836, Samuel Morse demonstrated the ability of a telegraph system to transmit information over wires. The information was sent as a series of electrical signals. With the advent of radio communications, an international version of Morse code became widely used. The most well known usage of Morse code is for sending the SOS distress signal: ... --- ... Radios came into general aeronautical use around 1929, although they had been employed with limited success as early as the First World War. The first radios were heavy, bulky and limited in range. Early radios were also limited to using dash-dot Morse code signals only. But, by the late 1920's radio sets had been improved. Developments, which allowed voice communications, were introduced, and the sets themselves became smaller. Advances were also introduced which allowed pilots to orient themselves along routes and airways by tuning into radio stations for flight information. Eventually, just prior to World War II, radios and radio stations were employed in early experiments with auto-landing systems.



It is to be noticed that today, the Morse code is still used in the aeronautics field for ground nav aids identification (VOR, DME, NDB...).

1.2.2.2. THE EARLY STEPS OF ACARS AOC

As early as 1978, airlines realized the potential of datalink by introducing the **Aircraft Communications Addressing and Reporting System (ACARS)** addressable application, to exchange company messages between their aircraft and their respective home bases.

ACARS was originally developed in response to a requirement from Piedmont Airlines to find a better way to measure flight crew duty times. The initial application was called “OOOI” and it offered **aeronautical operational control (AOC)** communications. OOOI gave actual times Out (of the gate), Off (the wheels weight on take-off), On (weight back on the wheels) and In (arrival at gate). As the system matured, organizations found that other time-sensitive information could be transmitted and received through the ACARS system, and the expansion was underway.

Maintenance services also found an important asset in the downlink of real-time aircraft parameters (refer to §4.2.4)

Thus, the original message service system has evolved over the past two decades to the generic Aircraft Communications And Reporting System or ACARS.

Today, over 6,000 aircraft are using ACARS worldwide on a daily basis, with more than 20 million messages exchanged per month.

1.2.2.3. ACARS EXTENSION TO ATC

ATC units began using the ACARS addressable application for Pre-Departure Clearance (PDC) at US airports in 1991 to alleviate the problem of frequency congestion. To obtain early benefits from CNS/ATM and in response to requests from operators using aircraft flying over the South Pacific, the “FANS-A package”, which uses the ACARS air/ground data communications network to support both AOC and ATS datalink applications, including ADS, CPDLC and AFN (refer to chapter 4) was standardized and developed by industry and approved for ATS in 1995 on a regional basis.

Today, FANS-A is used in airspace unsuitable for radar coverage, where the HF voice networks are either overloaded or ineffective such as oceanic regions (Pacific, Atlantic and Indian oceans).

Note: As the FANS environment is not part of this brochure; please refer to “Getting to grips with FANS” for further details on this concept.

1.2.2.4. THE ACARS LIMITATIONS

FANS-A has not followed the normal ICAO standardization process, since it was developed to support ATS by taking advantage of the existing ACARS technology. In addition, ACARS, which was designed to facilitate AOC, has inherent limitations, which impair datalink network growth development, and the implementation of CNS/ATM. These include protocol limitations, constraining access to proprietary networks, frequency allocation management, and insufficient performance to support future datalink applications. Therefore, an ICAO SARPs* compliant network, called ATN, has been defined to enable full performance of datalink (refer to chapter 7). Aside, the TCP/IP protocol which is widely used for ground/ground communication, is a candidate for wideband datalink (Gatelink,...).

These new datalink technologies will make possible to transport, with a better integrity, much larger amounts of data than is possible today. Furthermore, in combination with satellite-based navigation will also make it possible to revolutionize the way the international Air Traffic System and AOC operate and greatly enhance its capacity.

- ACARS is a private network
- ACARS datarate is limited (2400bits/sec)
- The applications scope is restricted to non-critical use.

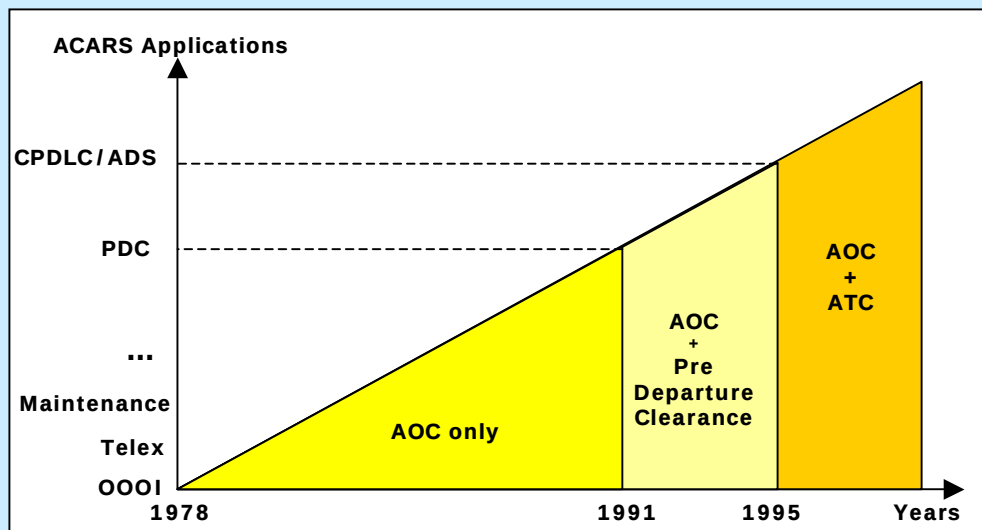
*: **SARPs**: the SARPs are international “**S**tandards **A**nd **R**ecommended **P**ractices” published by ICAO. National aeronautical regulations of countries member of ICAO shall comply with the content of these SARPs.

Please, bear in mind...

- Datalink is the exchange of digitized information between end-users.
- There is independence between applications and datalink media.
- Aeronautical communications can be classified as follow:

- **AOC** (Airline Operational Communications)
- **AAC** (Airline Administrative Communications)
- **APC** (Airline Passenger Correspondence)
- **ATC** (Air Traffic Control communications)

Scope of this
brochure



But ACARS has inherent limitations, which impair datalink network growth development and the implementation of CNS/ATM. Therefore, a new network called ATN (Aeronautical Telecommunication Network) is being developed.



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2.1. DATALINK GENERAL COMPONENTS

As shown on figure 2.1, the main elements of Air/Ground datalink are:

(i) Datalink airborne systems

On-board, messages are routed to appropriate end-systems such as Flight Management Computer, Aircraft Condition Monitoring System (ACMS), Cabin terminal, where they will be processed.

(ii) Datalink Service Providers (DSPs)

They are responsible for the reliability of the datalink media and the integrity of the exchanged messages. They ensure continuous coverage on a global scale, by using a variety of *Air/Ground datalinks* (VHF, HF, Satcom...) as well as operations centers and terrestrial *Ground-Ground networks*.

(iii) Airline ground processing systems

The ground processing system gathers in real-time all datalink traffic to/from the airline, providing the interface between the service provider and the airline operation center.

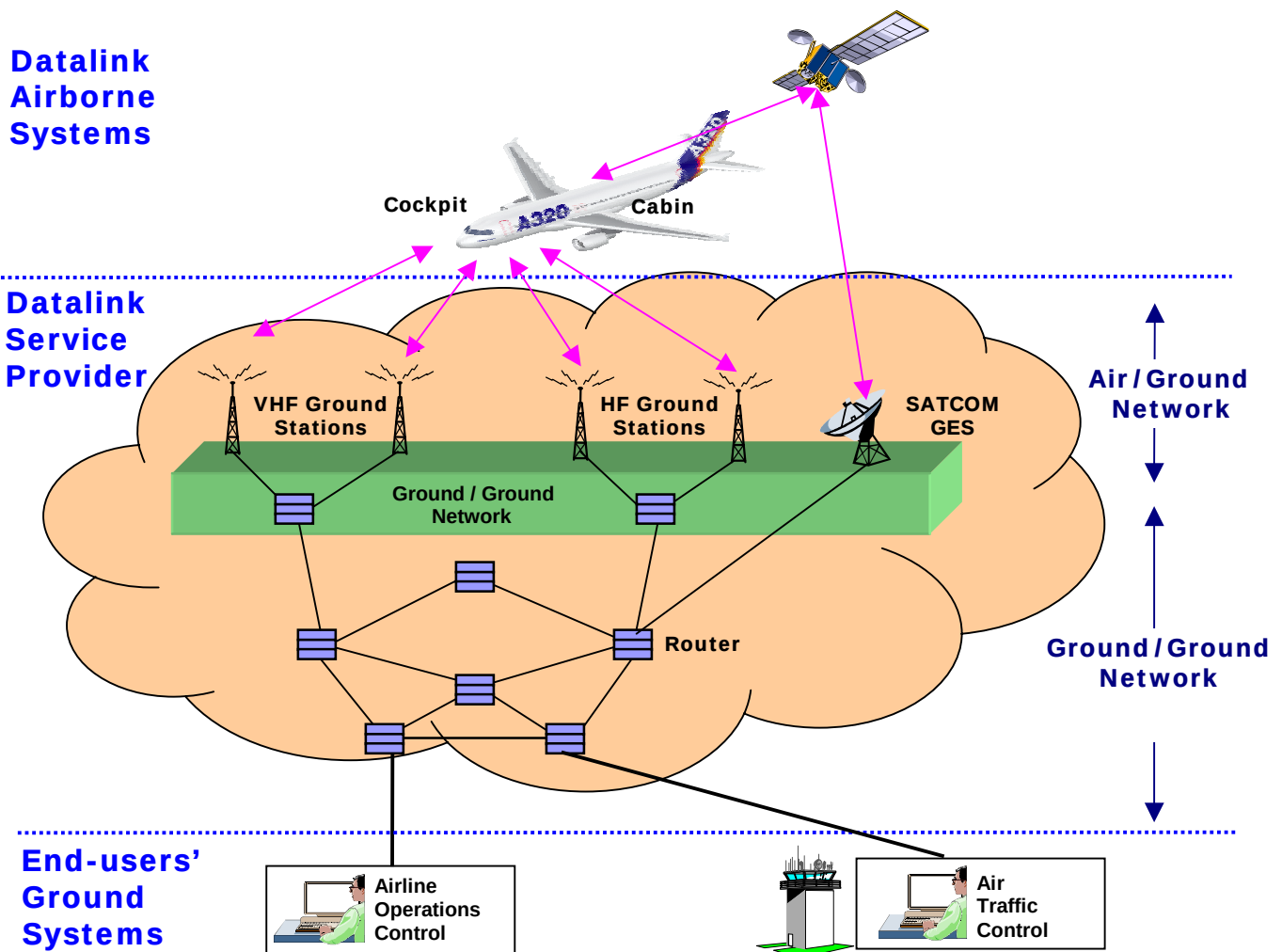


Figure 2.1
Datalink connects End-systems to transfer applications' content

2.2. AIRLINE GROUND PROCESSING SYSTEMS

A ground processing system is a tool gathering all datalink traffic to/from the airline. This system provides the interface (or Gateway) between the service provider and the airline operation center, enhancing the capabilities of the service provider ground networks and datalink avionics. It performs all datalink-specific tasks and maintains connection with service providers.

A core server, which routes and formats messages, is connected to back-end computer systems in the airline, such as: operations control systems, weight and balance calculations and takeoff performance calculation computers.

Note: Contacts and information on existing ACARS ground processing systems are proposed in part 4.5.

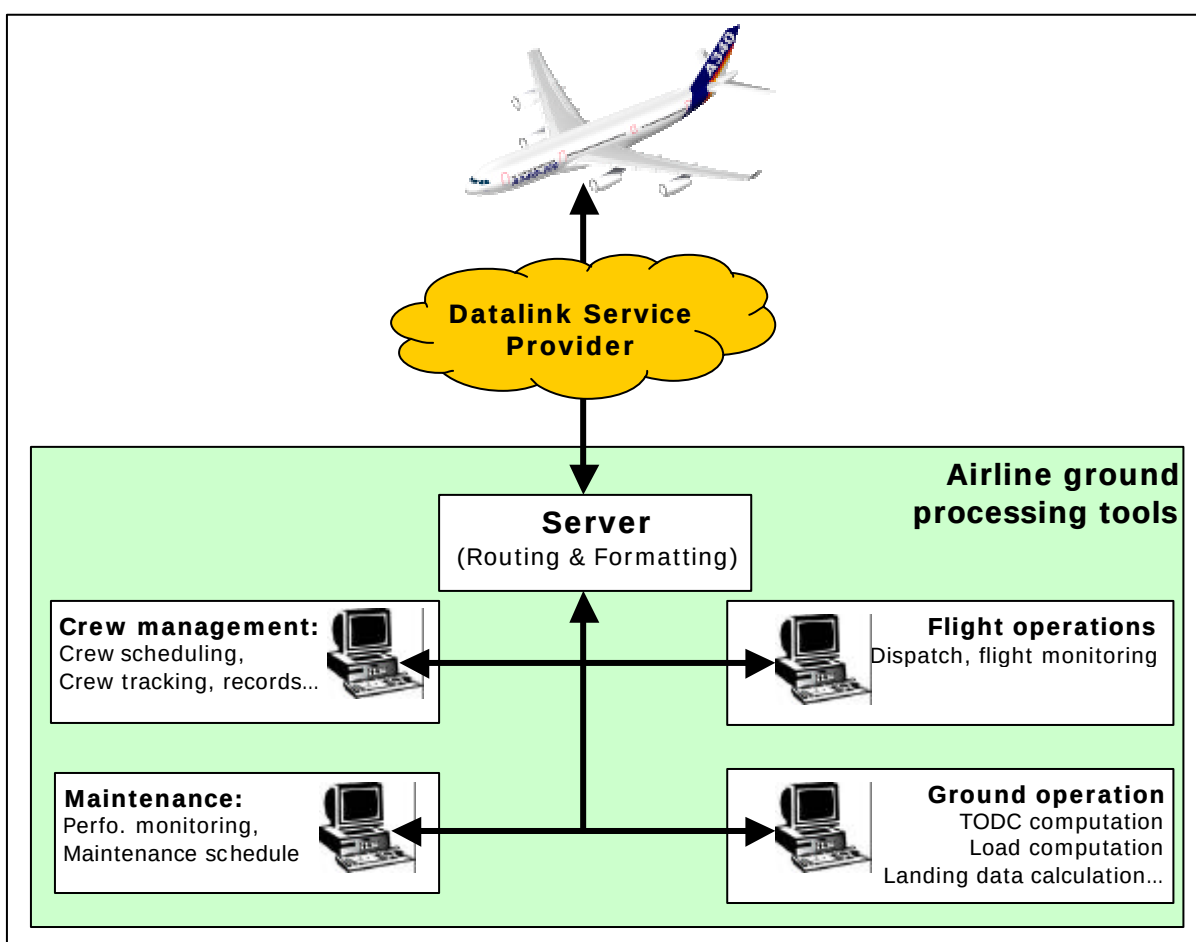


Figure 2.2:
Ground processing architecture

Ground processing systems provide real-time communication between airline computer systems and aircraft. This is what provides much of the day-to-day operational benefits and savings of datalink.

2.3. DATALINK SERVICE PROVIDERS (DSP)

2.3.1. GROUND/GROUND COMMUNICATION NETWORK

Another important point in implementing datalink is the communication service ensured by a message service organization, which is responsible for the reliability of the transmission media and the integrity of the message. The aviation communications message service organization has become known as the Datalink Service Provider or DSP.

The DSP is expected to create and manage the multiple datalinks that transmit a variety of messages related to specific applications, from the aircraft to the airline, and vice versa.

The service provider operates a network of Remote Ground Stations (RGSs) located at airports and other sites in order to provide VHF, HF and Satcom coverage in the areas where the aircraft fly (refer to chapter 6). There are several competing datalink service providers in the world, in some areas with overlapping service in e.g. Europe. The two dominating service providers are ARINC and SITA; they differ in terms of media coverage and price policy.

Private Datalink Service Providers (DSPs) use a variety of different air-to-ground datalink (VHF, HF and satellite) as well as operations centers and terrestrial datalink networks (ground-to-ground) to provide a message service, which ensures the end-to-end delivery of the information (or content application) being transferred between systems.

2.3.2. AIR/GROUND COMMUNICATION NETWORK

DSPs provide a variety of air-to-ground datalinks operating in different frequency bands to ensure continuous coverage in a cost-effective manner on a global basis.

- VHF datalinks (VDLs) are the most commonly used civil aviation datalink today. VHF datalinks are economical to implement and provide excellent operational performance (e.g., fast response times, 2 to 8 seconds), but are limited to line of sight coverage. This means a nominal range of about 240 NM at 30,000 feet and this range limit will apply to any VHF-based datalink.
- Existing satellite datalinks can provide global coverage but the current implementation provides no coverage in the Polar Regions (above and below 80 degrees of latitude). Satellite datalinks are more expensive per message transmitted and also slower than VHF in response time (12 to 25 seconds).
- HF datalink (HFDL), as implemented, provides near global coverage including over the northern Polar Regions. HFDL is an economic alternative to satellite datalinks for wide area coverage, but its message transit time (80 seconds) is slower than satellite.

VHF, VDL Mode2, satellite and HF datalinks can transfer character-oriented ACARS messages and bit-oriented FANS messages between appropriately equipped aircraft and end-systems.

VDL Mode2, Mode S and satellite datalinks can also transfer messages that use the Aeronautical Telecommunications Network (ATN) to communicate with appropriately equipped aircraft.

For further information on these datalink technologies, refer to chapter 6.

VHF, VDL Mode2, HF, satellite and 1090 Mode S datalinks are operational datalinks, whereas VDL4, Universal Access Transceiver (UAT) and VDL Mode 3 are still tested.

Downlink Process

The ground station (VHF, HF or Satcom) that receives the downlink message forwards it to the service provider's central datalink processor. The central processor reformats the message into a ground-ground format and sends it to the airline. There, the airline's ground processing system receives, identifies and forwards the message to one or more end-users.

Uplink Process

The uplink process is more or less the reverse of the downlink process. A message is created by an end-user or end-system, converted into an ACARS format and sent to the DSP, which forwards it to the aircraft.

2.4. DATALINK AIRBORNE SYSTEMS

2.4.1. BASICS

The core of the airborne datalink system is called ACARS router; it routes the message received from the ground to appropriate end-systems on-board the aircraft, such as Flight Management Computer, Aircraft Condition Monitoring System (ACMS), Cabin terminal, Airshow and cabin printer.

For messages initiated by the aircraft, the ACARS router is able to route automatically reports generated by aircraft systems or by the pilots to the ground systems (airline, engine manufacturer, ATC, etc). This routing takes into account the airline policy, the regional settings and the nature of the message.

The on-board architecture may vary from one aircraft to another; for instance, for Airbus Long Range and Single Aisle aircraft, since 1999 the router can be embedded into the Air Traffic Service Unit (ATSU), as defined figure 2.3.

This brochure focuses on ATSU avionics. Differences exist with ACARS MU and are not in the scope of this document. The applications described in chapter 4 can be implemented with both systems

2.4.2. AIRBORNE COMPONENTS FUNCTIONAL DESCRIPTION

The avionics unit, called Air Traffic Service Unit (ATSU), has been developed to cope with datalink communications. The ATSU host platform fulfills the following functions:

- It manages available communications media through an automatic selection (transparent to the pilot)
- It manages the MCDU and DCDU displays (if installed)
- It routes messages to the appropriate end-systems and peripherals

Thus, the ATSU host platform is able to independently host applications with **various criticality levels**:

- **ATC essential applications** (software level C as per DO178B).
- **AOC applications**, gathering all non-essential applications (software level E).

The ATSU is a hosting platform, which has been designed so as to take provision of all foreseen evolutions. This modularity concept for both software and hardware permits to ease the quick and dependable introduction of all AOC and ATC datalink capabilities during the transition to the ultimate full FANS.

Two types of airborne datalink applications exist depending on their location: internal or external to the ATSU.

The diagram below shows a synthesis of the integration of air/ground data exchanges in the ATSU context:

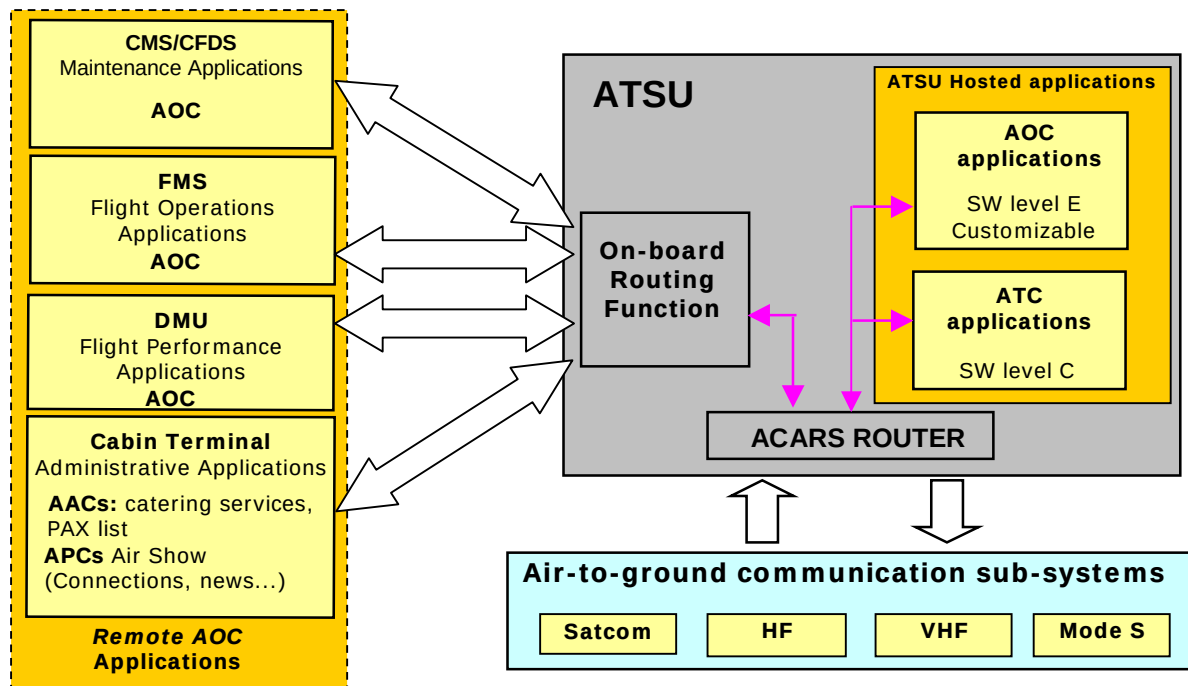


Figure 2.3:
Integration of Air/Ground applications

Note: The segregated applications are installed on the aircraft interface software; they perform their operational tasks by using services provided by the host platform.

2.4.2.1. DATALINK APPLICATIONS RESIDENT IN THE ATSU

- **Airline Operational Communications (AOC) type applications:**
Provides operational functionality and take into account airline specificity (thanks to high level of customization): Departure/Arrival times reports, delay/Estimated Time of Arrival, diversion/return to gate reports, gate assignment, etc (refer chapter 4).
- **Air Traffic Services (ATS) type applications:**
 - ATIS (Automatic Terminal Information Service)
 - Departure Clearance
 - Oceanic Clearance
 - AFN (FANS A)
 - CPDLC (FANS A)
 - ADS (FANS A)As the ATC software cannot be customized, this brochure only details the AOC application software.

Note: ATSU software (core, AOC and ATS applications, databases) can be loaded via the aircraft data loader.

2.4.2.2. DATALINK APPLICATIONS RESIDENT IN THE FMS

Several flight operations applications are resident in the **FMS** (Flight Management System). The FMS-ACARS function gives an interface between a ground station and an onboard FMGC, allowing data transmission between these two computers via the ATSU (or ACARS MU). Thus, several reports (such as progress reports, flight plan updates, wind data...) can be exchanged (refer to §3.2.4 for further details on FMS AOC applications).

2.4.2.3. DATALINK APPLICATIONS RESIDENT IN THE CMS/CFDS

Some maintenance applications are embedded in the **CMS/CFDS** and allow the transmission of maintenance reports to the ground. These reports are detailed in part 3.2.3.

2.4.2.4. DATALINK APPLICATIONS RESIDENT IN THE DMU

AOC applications directly related to flight and maintenance are integrated into the **DMU**. They enable the exchange of reports concerning aircraft, engines, APU performance and condition monitoring (refer to part 3.2.3).

2.4.2.5. DATALINK APPLICATIONS RESIDENT IN THE CABIN TERMINAL

Passenger and crew dedicated applications are located in the Cabin terminals: the Digital Interface Unit (DIU) and the Cabin Passenger Management Unit (CPMU); for instance, connecting flight information or Airshow.

The functionalities of these applications are described in §3.2.5.

Note: CFDIU/CMC, FMS, DMU and Cabin Terminals are named remote AOC peripherals.

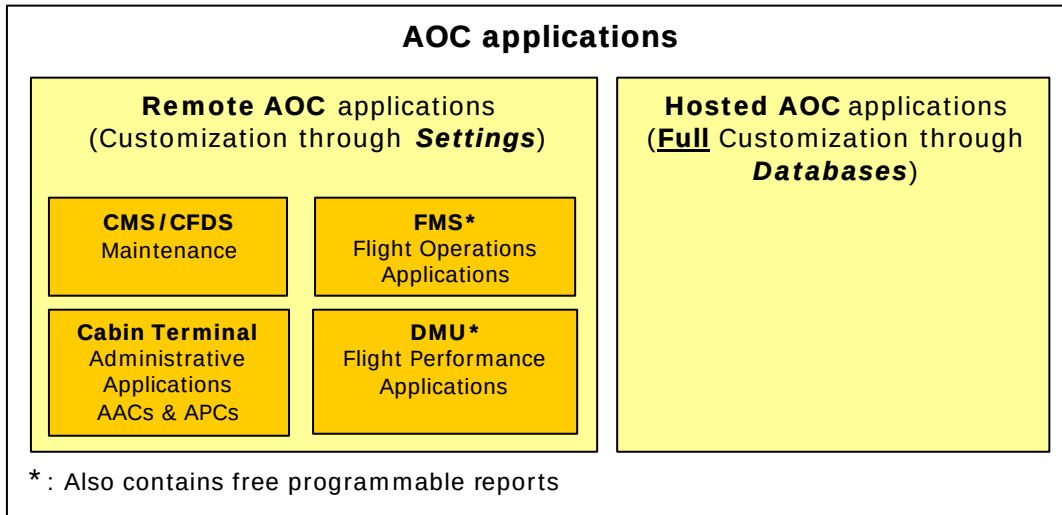


Figure 2.4:
AOC applications breakdown synthesis

Please, bear in mind...

Datalink components description

The main elements of air/ground datalink are:

- **Communication Media or “Pipes”**
Based on VHF, Satellite, HF or even ModeS, they provide the connection between airborne and ground end-systems operated by the Datalink Service Providers (DSP).
- **Airlines’ ground processing systems**
The ground processing system gathers in real-time all datalink traffic to/from the airline, providing the interface between the service provider and the airline operation center. A core server routes and format messages to back-end computer systems in the airline, such as: operations control systems, weight and balance calculations and takeoff performance calculation computers.
- **Datalink Service Providers (DSPs)**
They are responsible for the reliability of the “pipes” and the integrity of the exchanged messages. They ensure continuous coverage on a global scale, by using a variety of A/G datalinks as well as operations centers and terrestrial ground-ground networks.

Please, bear in mind...

Datalink components description (continued)

- **Applications**

Enabled by datalink communications, they produce the beneficial outcomes for the aircraft operators and the ATC.

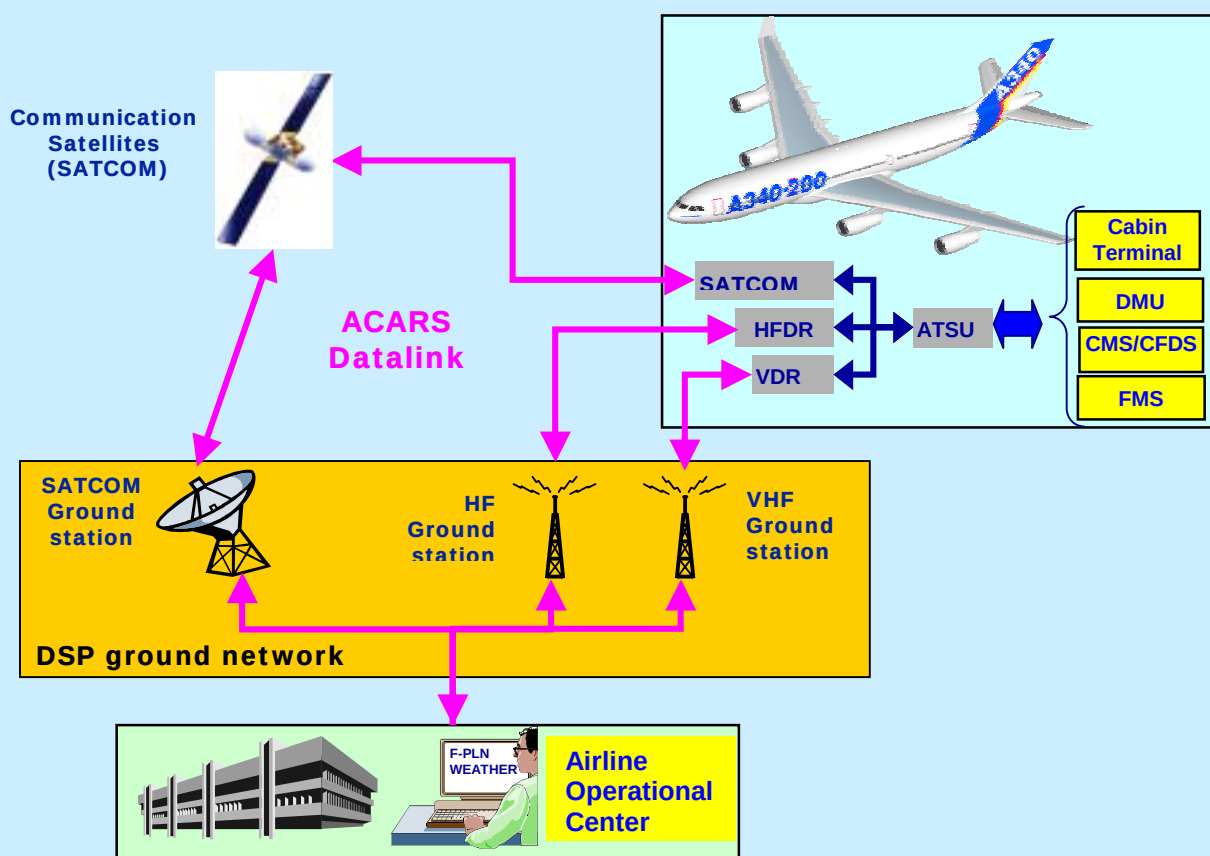
The core of the airborne datalink system is called ACARS router. It routes received messages from the ground to appropriate end-systems on-board the aircraft, such as Flight Management Computer, Aircraft Condition Monitoring System (ACMS), Cabin terminal ...

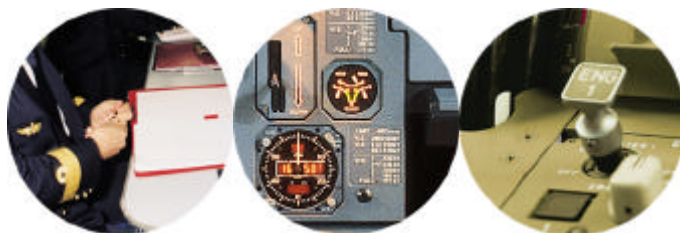
The avionics unit, called Air Traffic Service Unit (ATSU), has been developed to cope with datalink communications and embeds the ACARS router.

Two types of airborne datalink applications exist, internal or external to the ATSU.

- **ATSU Hosted applications:** AOC and ATC
- **ATSU Remote AOC applications** in ATSU peripherals: FMS, DMU, CMS/CFDS and Cabin Terminals.

Hosted AOC applications can be fully customized whereas remote AOCs customization is done through settings.





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3.1. ATSU HOSTED AOC SOFTWARE

The AOC Software provides operational data communications between the aircraft and the airline facilities on the ground. AOC software functions are accessible through the MCDU pages and can be customized to take into account airlines operations specificity.

A basic set of AOC functions, called “Standard AOC”, is defined by AOC vendors and approved by Airbus. It defines functions such as delays, reports, weather request or initialization. Only this Standard AOC software (as defined in Appendix A) is available in Airbus catalogue as an option. Customized AOC are not covered by Airbus and cannot be offered to the customer through the RFC process. However customer must be informed that custom AOC software can be directly purchased from the AOC vendor.

Furthermore, ground support tools can be provided by AOC vendors (Rockwell-Collins and Honeywell) to allow customization of the AOC database (refer §3.1).

Note: The AOC application software modification requires in-depth knowledge of the AOC design and is usually performed by the vendor.

Airbus provides a minimum and maximum perimeter for the development of AOC software, either Standards or Customized.

The ATSU is certified to operate with any AOC (standard or customized). Modifications of AOC do not require any re-certification by the airline before loading it on the aircraft, as a level E software per the D0178B (no need of certification, refer to the “Glossary of terms”).

Note: Most customers use customized AOC software.

Documentation (specifications, pilot's guide, etc) about AOC functions (Standard or customized) can be obtained from the AOC vendors.

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3.2. ATSU REMOTE AOC SOFTWARE

For these applications, the ATSU acts like an airborne router in charge of:

- Receiving ground messages and routing them to the right AOC peripheral depending on the destination address (refer Appendix F).
- Acquiring messages from AOC peripherals and sending them to the ground according to the company routing policy

Note: To interface with the remote AOC peripherals the ATSU uses a file transfer protocol as defined in ARINC 619 specification (some broadcast labels are also used). These labels/sublabels processed by the ACARS router are provided in Appendix F and should be inserted in the ACARS frames to address specific end-systems.

3.2.1. OPERATION PRINCIPLES

The remote AOC applications use 3 different operating modes for messages (or reports) sending to the ATSU.

- **Manual command**

The crew through a MCDU menu handled by the concerned AOC peripheral sends a manual command. The crew is kept aware of the result of the transmission by MCDU messages (successful or failed).

Note: Only one transmission attempt is done: to try again, the crew has to request another transmission.

- **Automatic mode**

Automatic mode is programmed into the peripheral (triggering event, period...). When the conditions are met for automatic transmission, the peripheral sends the required report to the ATSU.

Note: The remote AOC peripheral periodically attempts the message transfer until successful.

- **Uplink request**

An uplink report request can be received from ground and transmitted by the ATSU to the concerned peripheral. An uplink request contains the type of the report to be generated and transmitted (report number). It may contain additional information like trigger conditions.

Note: The ATSU has no knowledge of the content of the remote AOC data.

3.2.2. DMU AOC APPLICATIONS

The DMU is part of **AIDS** (Aircraft Instrument Data System) on **A320** family and **ACMS** (Aircraft Condition Monitoring System) on **A330/A340**.

Basically, the AIDS/ACMS provides the capability to transmit reports to the ground for the following applications:

- *Aircraft performance* monitoring
- *Engine condition* monitoring
- *APU health* monitoring

The ATSU downlinks the following DMU reports to the ground:

Engine cruise report,	Cruise performance report,
Engine take-off report,	Engine report on request,
Engine gas path advisory report,	Engine mechanical advisory report,
Engine Trim Balance (A330/A340 only)	Engine divergence report,
Engine start report,	Engine run up report,
APU MES/IDLE report,	APU shut down report,
Free programmable report #1,	Free programmable report #2,
Free programmable report #3,	Load report,
ECS report,	RAT report,

The above listed reports can be either report stored in the DMU buffer after automatic generation, or reports generated on manual request or on ATSU uplink request.

The DMU can be programmed in order to automatically transfer reports to the ATSU as soon as they are generated. The automatic transfer depends on the AIDS/ACMS setting. A message is considered delivered by the DMU when the ground acknowledgement is forwarded by the ATSU.

Note: The structure of the message transfer complies with the ARINC 619 specification.

3.2.3. CMC/CFDIU AOC APPLICATIONS

The **CFDIU** (Centralized Fault Data Interface Unit) is part of the A320 family avionics and **CMC** (Central Maintenance Computer) of A330/A340 avionics.

- **CMS/CFDS downlink reports**

The ATSU downlinks the following CMC/CFDIU reports to the ground:

- Post Flight Report (on ground)
- Current Flight Report (in flight)
- Real Time Failure (in flight)
- Real Time Warning (in flight)
- Bite Data Messages
- Class 3 Report (on ground) (A340/A340 only)

The CMC/CFDIU can automatically transmit the **Post Flight Report (PFR)** to the ATSU at the end of the flight leg. The PFR can also be transmitted on manual command or on uplink request.

The **failure messages** can automatically be transmitted in real-time by the CMC/CFDIU to the ATSU. When the CMC/CFDIU report contains failure messages, which have not been transferred yet to the ATSU, the CMC/CFDIU automatically tries to transfer the oldest one. The CMC periodically attempts to transfer this failure message until the message is successfully downlinked until deletion.

The **ECAM warning messages** are automatically transmitted by the CMC/CFDIU to the ATSU with the same logic as for the failure messages.

Any **BITE data messages** can be manually downlinked from the CFDIU/CMC MCDU pages.

The CMC transmits the **Class 3 report** to the ATSU on uplink request or on manual command.

Servicing report

When this option is available, the CMC is able to downlink the servicing report.

The CMC transmits the Servicing Report to the ATSU:

- Automatically, at the end of the flight leg
- On uplink request
- On manual command

The AOC hosted application within ATSU creates and transmits a documentary data of the required format when requested by the CMC and when entering the 'IN' OOOI state.

Note: This function, which is a CMC option, is now basic on standard L6A/L6B

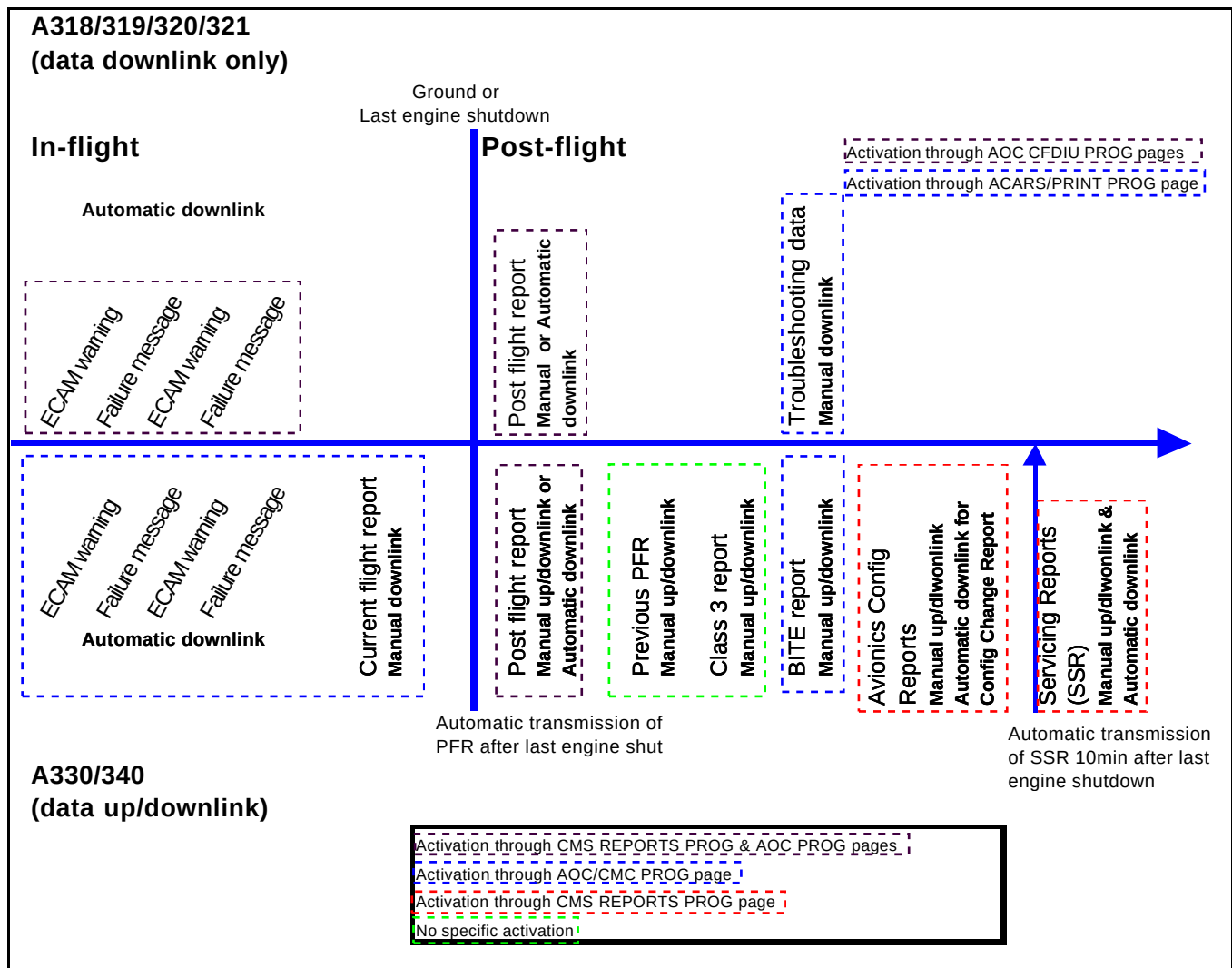
- **CMS/CFDS uplink requests**

The CMS/CFDS uplink request (Request for Report Generation) is transmitted by the ATSU to the CFDIU to request the generation and transmission of a report. The request will contain at least the IMI of the message to downlink.

- **Active functions programming**

Activations of functions in the CMC/CFDIU, i.e. **automatic report transmission** to the ATSU, are programmed in the ATSU. The ATSU sends periodically to the CMC/CFDIU this information, allowing the CMC/CFDIU to know which kind of report has to be downlinked. Active functions programming concern:

- ECAM warning report
- Failure report
- Post Flight Report
- BITE data report (A330/A340 only)



Reports	A320	Auto	Manual	Activation		Comments	A330	A340	Auto	Manual	Gd REQ*	Activation		Comments
				CFDIU	AOC							CMC	AOC	
PFR (correlated*)	X	X	X	-	X		X	X	X	X	X	X	X	
PFR (non correlated*)	X	X	-			Scheduled in CFDIU	X	X	-	X	-	-	X	From CMC L6B
Current Flight Report						In flight only								In flight only
* Current leg report	X	-	X	-	-	From CFDIU	X	-	X			-	-	
* Current leg ECAM	X	-	X	-	-	STD 9B	X	-	X			-	-	
Real time failure	X	X	-	-	X		X	X	-			-	X	
Real time warning	X	X	-	-	X		X	X	-			-	X	
BITE data	X	-	X	X	-		X		X	X	X	-	X	
Class 3 report	-	-	-	N/A			X	-	X	X	X	-	-	
Servicing report	-	-	-	N/A			X	X	X	X	X	X	X	A/C with CMC opt* activated or with CMC L6A/L6B

Table 3.1:
CMS/CFDS options synthesis

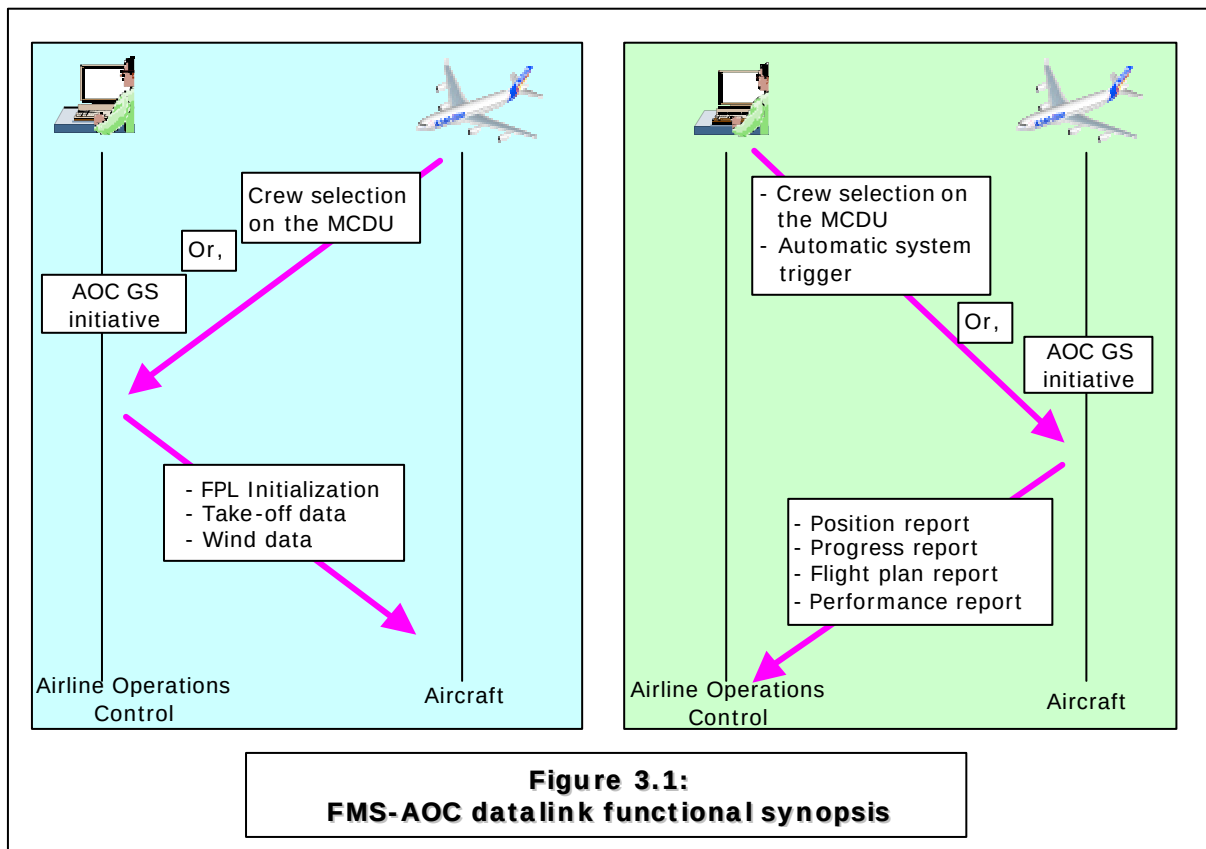
*: Correlation between ECAM warnings and failure messages

3.2.4. FMS AOC APPLICATIONS

- **Air-ground data exchanges**

The FMS supports bi-directional data transfer through datalink. The “mini-ACARS” function of the FMS grants data broadcast from the FMS to the ATSU/ACARS.

The ACARS Router function determines which FMS#1 or FMS#2 is intended to receive the uplink data by reference to the sub-label characters in the uplink message (refer table 2.1). The FMS datalink message structure is explained in the **FMS Datalink Ground Users Manual** provided by Honeywell.



The “full ACARS” function allows mini-ACARS function along with so-called FMS AOC functions described below:

- Flight plan insertion (“FPL Init” MCDU page)
- Takeoff data,
- Wind data,
- Aircraft performance data,
- Reports: position, progress, flight plan, performance

Note: It works the same whether an ATSU or an ACARS MU is fitted

It can be enabled or disabled on either 1st or 2nd (or “FMS2”) generation FMS and the interface customized in the FMS AMI (Airline Modifiable Information) or APF (Airline Policy File) (refer to §5.3.7).

Datalink data exchanges		
	Downlink messages	Uplink messages
Message type	Position report	Initialization data
	Progress report	Take-off data
	Flight plan report	Wind data
	Performance report	
Triggering condition	Automatically (programmed triggers in the AMI/APF)	In response to a crew request Or, Airline host initiative
	At a given time,	
	Upon flight phase transition,	
	At periodic intervals,	
	When reaching a specified threshold,	
	When reaching a given waypoint	
	In response to an AOC ground station request	
	Upon crew request using a prompt on the MCDU	

Table 3.2
FMS datalink messages

- **Report content:**

Flight plan report downlinked to the airline

Flight number, active route, active alternate route, company address, ground address, time stamp and scratch pad.

Flight Plan Reports downlink for ATC

Flight number, active route, active alternate route, company address, ground address, time stamp

Performance Data report downlink

Performance data, ground address, time stamp and scratch pad.

Position report downlink

Company address, ground address, time stamp and scratch pad.

Progress report

Destination report, flight number, company address, ground address and time stamp

- **FMS Printer interface**

The FMS-printer interface allows automatic printing of data received by the FMS over ACARS, of triggered flight reports, and manual printing of reports.

Customization is possible in the FMS ACARS/PRINTER policy file or AMI (refer §5.3.7).

3.2.5. CABIN TERMINALS APPLICATIONS

The ATSU is connected to the Digital Interface Unit (DIU) and the Cabin Passenger Management Unit (CPMU).

The communication principles between the ATSU and the Cabin Terminals are identical to the other remote AOC peripheral. The ATSU transmits uplink messages from ground to the Cabin Terminals and sends to the ground downlink messages, without processing the application data contained in the messages.

No manually requested reports are used. The transmission are only automatic or on ground request.

It is to be noticed that interface between the ACARS function and the cabin can be defined specifically by each operator.

For instance, the PFIS (Passenger Flight Information System) can be connected to the ATSU. In that case, the ACARS function / PFIS interface allows to display information such as the gates for connecting flights through the Passenger Entertainment System

Note: Connection of specific cabin equipment to the ACARS function is also possible, provided that the interface is defined according to ARINC specifications.

3.3. PROSPECTIVE APPLICATIONS

Aside the applications detailed here above, which are organized around the ATSU and transmitted over ACARS, other datarate demanding functions can be implemented using other media.

Emerging technologies based on IP (Internet Protocol), such as Satcom Swift64 or HSD (High Speed Data) services (refer to §6.2.3.4), or even Gatelink (refer to §6.2.4), provide a high data rate (30 to 500 times greater than ACARS).

It is to be noticed that avionics applications cannot use these transmission means, but crew and passengers can benefits from them:

Example of crew applications:

- Charts and maps loading
- Graphical Weather
- Flight preparation files
- ...

Example of passengers' applications:

- E-mail / Internet
- Electronic duty free shopping
- Reservation and ticketing
- ...

Please, bear in mind...

- **ATSU Hosted AOC applications**

- AOC software
 - o Standard (Honeywell or Rockwell-Collins), or
 - o Full customization possible (within Airbus defined perimeter)
- ATC software – not customizable

- **ATSU Remote AOC applications**

- **Operation principles**

- o Manual command (through MCDU)
- o Automatic mode (pre-programmed triggering conditions)
- o Uplink request (from ground, transparent to the crew)

- **DMU**

DMU provide the capability to transmit reports to the ground to achieve:

- o *Aircraft performance* monitoring
- o *Engine condition* monitoring
- o *APU health* monitoring

- **CMS/CFDS**

CMS/CFDS provide the capability to transmit maintenance reports to the ground concerning:

- o In-flight and Post Flight Report
- o Real Time Failure & Warning
- o Other miscellaneous maintenance reports

- **FMS**

The FMS-AOC datalink allows data exchange over the ACARS network between the aircraft's FMS and the ground AOC of the following:

- o Flight plan initialization
- o Takeoff data
- o Wind data
- o Aircraft performance data
- o Reports: position, progress, flight plan, performance

- **Cabin Terminals applications**

The ATSU transmits uplink messages from ground to the Cabin Terminals and sends to the ground downlink messages, without processing the data contained in these messages

For instance, the PFIS (Passenger Flight Information System) can be connected to the ATSU to display information such as the gates for connecting flights...

- **Prospective applications**

Emerging technologies based on IP (Internet Protocol), such as Satcom Swift64 or HSD (High Speed Data) services, or even Gatelink, provide a high data rate (30 to 500 times greater than ACARS).

Note: avionics applications cannot use these transmission means, but crew and passengers can benefit from them (e.g. weather map update).



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Important notices

- Implementing ACARS is **demanding** and requires **the contribution of all involved departments**. Ground and on-board applications must be developed in parallel so as to avoid incompatibility problems.
- All the information included in this chapter is **examples** based on true airline operations. The aim of this chapter is to show the applications that **could be implemented** by operators.
- It is possible to sent **encrypted data** so as to protect their content.
- Some of the following applications require the **approval of the national authority**.
- AOC applications HMI should be developed so as to **alleviate crew workload**.

4.1. AIRCRAFT OPERATIONS ACTORS

4.1.1. GENERAL

While the operations of each specific airline may differ, there is a certain amount of similarity among each airline's structure. Many actors and department are involved to achieve higher profitability in aircraft datalink operations. Furthermore, numerous actors (ATC, ground handlers, fueller...) assist the airline to affect the operational sequence of a flight in the tactical phases.

A good co-ordination between all these entities is a fundamental factor that requires much information to be exchanged.

Many interactions between actors and exchange of data can more and more be supported by datalink technologies. Therefore, datalink is a key element of CDM (Collaborative Decision Making), which aims at improving airport operations by a better sharing of information between actors (airport, airlines, ATC...).

This chapter identifies information areas that can be covered by datalink applications.

4.1.2. ACTORS OVERVIEW

Today, the mains actors involved in the aircraft operation process, aside the crew, are the following:

- Airline Flight Operations
- Airline Crew Management
- Maintenance
- Ground handling
- Catering services
- Fuelling services
- Cleaning services
- Passenger assistance
- The ATC (Air Traffic Control)

The exchanged information can be covered either by voice or datalink. The later presenting many advantages such as workload savings, anticipation and reduced turn-around times.

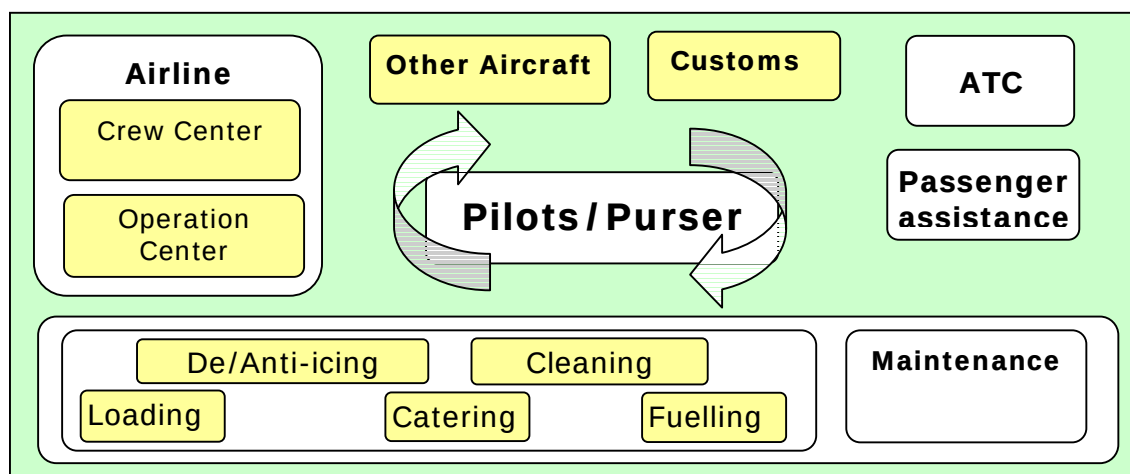


Figure 4.1
Information exchanged between Pilots/Purser and other actors

4.2. BASIC DATALINK APPLICATIONS

The following applications are usually the firsts implemented by airlines when starting datalink operations.

In major airlines using datalink extensively, these messages represent more than 50% of the traffic.

Note: *OOOI* and *Free text telex* can be used by all airlines' departments.

4.2.1. OOOI (OUT-OFF-ON-IN)

ATSU hosted AOC application (standard)

The OOOI (Out, Off, On and In) messages are automatic movement reports used to track aircraft movements, flight progress and delays. As explain in part 1.2.2.2, the "OOOI" was the first application implemented over ACARS in 1978.

The OOOI messages are sent automatically, triggered by sensors on the aircraft (such as doors, brakes, gears...).

Note: It is possible to customize the event associated to each report.

- An "**Out report**" is sent when the aircraft leaves its parking position (at the gate or remote). At this time, the system logs the OUT time and automatically downlinks an Out Report message. Parking brake released and/or all doors closed can be triggering conditions.
- An "**Off report**" is sent when the take-off is detected, for instance, thanks to air/ground sensors on landing gears. Initial ETA parameter can be part of the message content.
- As for the "Off report", an "**On report**" is sent at aircraft touch down (the air/ground sensor shows "ground").
- An "**In report**" is sent when the aircraft arrives at its parking position (at the gate or remote). Parking brake set and/or an open door can be a trigger.

Other messages (such as "Return to gate" or "Touch and go") can be sent automatically. For instance, if an "In event" is detected after an "Out event", a "Return to gate" message will be sent automatically to the flight operations.

4.2.2. WEATHER

METAR and TAF (airport weather information) can be received over ACARS and printed on the cockpit printer. This application allows the pilot to get updated weather conditions and forecast at the departure and destination airports as well as at other airports along the route.

Examples of a printed METAR/TAF from Toulouse-Blagnac airport:

```
METAR LFBO 300630Z 11021G32KT 9999 FEW015 SCT050 BKN110 10/06 Q1005  
TEMPO 13023G35KT=  
  
TAF LFBO 300500Z 300615 12018G28KT 9999 FEW012 BKN070 BKN230 TEMPO  
0608 RA TEMPO 0613 13024G38KT TEMPO 1315 13028G42KT=
```

SIGMET are SIGNificant METeorological advisories regarding significant meteorological conditions that could affect the flight. It is also possible to automatically uplink SIGMET information for FIRs ahead of the flight.

EBBR SIGMET 2 VALID 110800/111200 EBBE - FIR BEAUVECHAIN SEV TURB FCST
BTN FL250 AND FL350 STNR WKN=

Note: It is possible to set ground systems (using addressing masks) to broadcast SIGMET data to impacted aircraft only.

4.2.3. FREE TEXT TELEX

ATSU Hosted AOC application (standard or customized)

On board the aircraft, the pilot has the possibility to send so-called “Free text” messages to the ground. These messages can be used for miscellaneous communications that are not covered by existing AOC applications. The destination of these telexes can be pre-programmed or manually entered by the pilot (through MCDU).



Figure 4.2:
Example of AOC Telex MCDU page

As shown on figure 4.2, these free text telexes can be addressed to:

- Maintenance
- Engineering
- Dispatch
- Flight Operations
- Crew management
- Flow (slot)
- Station
- Traffic
- Another aircraft
- Pilot specified address

Note: Free text telex offers a significant improvement in capability to communicate reliably during a flight compared to the traditional usage of HF/VHF radio.

In case of FANS-equipped aircraft, the use of free text messages to ATC should be limited to exceptional cases, as they cannot be treated by the automated station of the controller as standard ATC messages.

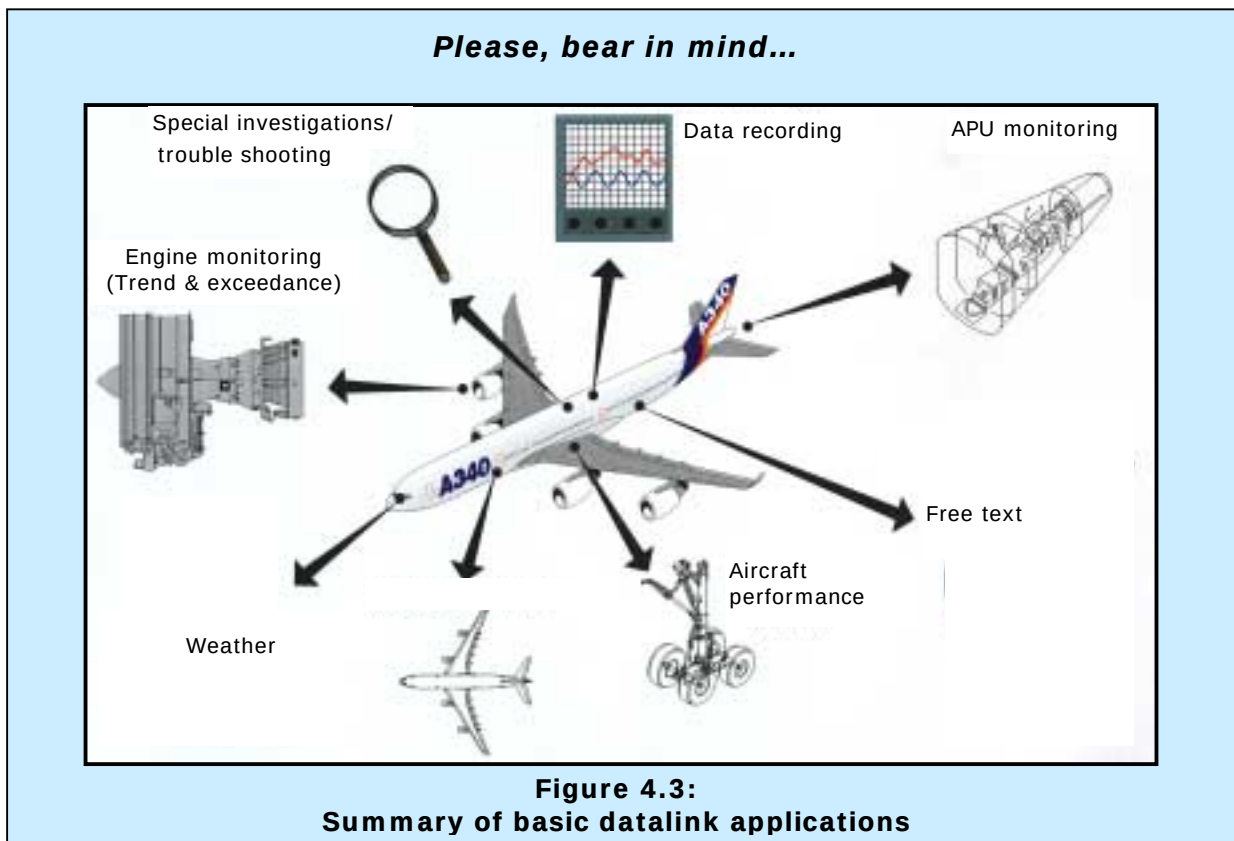
4.2.4. MAINTENANCE

Datalink also contributes to maintenance. Aircraft systems status and engine data can be downlinked in real-time from a central maintenance system in order to optimize the treatment of unscheduled maintenance events, which results in delays and workload reductions. Different systems are used to downlink these parameters, such as on-board avionics (DMU, CMS/CFDS) or customized AOC MCDU pages (manually filled by the pilot).

- During the pre-flight phase, a MEL message from the maintenance can be uplinked to the cockpit printer so as to ensure the flight is correctly dispatched.
- The DMU provides the capability to transmit to the ground reports for the following applications:
 - Aircraft performance monitoring
 - Engine condition monitoring
 - APU health monitoring
- The CFDS/CMS makes it possible to downlink data so as to monitor the aircraft and prepare maintenance actions.
- The ATSU AOC software enables reports (engines, fuel, oil) to be customized and sent to the maintenance department through MCDU pages

In order to optimize the treatment of these messages, ground-based software are used such as Airbus AIRMAN processing tool or LOMS for FOQA (Flight Operations Quality Assurance).

It is to be noticed that automatic downlink of engine parameters to the engine manufacturer often results in warranty benefits.



4.3. DATALINK APPLICATIONS PER END-USERS

This part presents a set of applications classified by users (airline's departments).

4.3.1. AIRLINE FLIGHT OPERATIONS

4.3.1.1. AIRLINE FLIGHT OPERATIONS - PRE-FLIGHT

- **Flight initialization**

ATSU Remote AOC Application (FMS) or Hosted AOC application (customized)

Once in the cockpit, one of the first flight crew actions is to request ACARS system initialization (entering only the company route or the ATS flight Id. for instance). This "Init request" informs the airline ground systems that the aircraft is being prepared for departure, and can trigger the uplink of many initialization data such as: Dep/Dest. Airport, STD/ETD, Flying Time.

One of the main advantages of this initialization procedure is that the pilot does not have to manually enter these data through the MCDU.

It is also possible to set the ground processing system so as to uplink other data when receiving the *Init Request*; for instance Preliminary and Final Loadsheet, NOTOC (dangerous goods manifest), updated crew list, flow information (as described hereafter).

The pilot can also request a flight plan uplink from the cockpit via ACARS. This flight plan is printed or displayed on the MCDU.



Figure 4.4:
Example of FMS initialization MCDU pages

- **Weather information:**

ATSU Hosted AOC application (standard or customized)

METAR/TAF, SIGMET and ATIS messages can be requested by the crew to prepare their departure and automatically uplink from ground systems using datalink.

The **Airport Traffic Information Service (ATIS)** message contains information regarding the airport takeoff/landing procedures and MET conditions

Note: ATIS over datalink, which is called Digital-ATIS (D-ATIS), is defined by the AEEC623 specification (refer to paragraph 4.3.8.3).

- **NOTification TO Captain (NOTOC)**
ATSU Hosted AOC application (customized)

The NOTOC contains a specification of the materials on board that may require special handling or procedures in case of an emergency. It also contains provision for information regarding other "Special Loading" such as live animals, perishable goods and dangerous goods.

The NOTOC message can be sent automatically to the printer as a free text format, at the same time as the Loadsheel.

- **Loadsheel over ACARS**
ATSU Hosted AOC application (customized)

Determination of the aircraft's center of gravity and total weight is necessary, and, required by regulation before every take-off. All these critical data about the airplane's weight and balance are contained in the loadsheel. The loadsheel is usually delivered by hand to the crew before departure. The Final loadsheel is typically the very last document that the pilot must have before departure.

Timesaving in the delivery of the Loadsheel is therefore very important in order to reduce turnaround times.

The loadsheets (preliminary and final) can be automatically delivered over ACARS and printed directly to the cockpit.

The preliminary loadsheel can be uplinked in response to the ACARS Initialization (refer §4.3.1.1). The data in the Preliminary Loadsheel (ZFW, TOW, LW, DOW...), amongst other things, allows the pilot to make a preliminary takeoff data calculation (refer hereafter).

The final loadsheel is uplinked automatically when all load control releases have been made by the Load Controller. It is recommended to get the acknowledgment from the crew. The pilot can accept the loadsheel (including also the NOTOC if applicable) by sending an electronic signature to the ground.

Note: A copy of the final loadsheel must be printed on ground, signed by the loadsheel agent and stored in the flight's file.

Loadsheel sent via ACARS allows minimizing the need for last minute change procedures.

Note: Last minute change means any change concerning traffic load (Pax, baggage, cargo, fuel) occurring after the issuance of the load and trim sheet.

Signing the Final Loadsheet

ATSU Hosted AOC application (customized)

It is possible to customize AOCs (refer to chapter 3) to allow crews to sign electronically the final loadsheet (through personal PIN code).

Note: This signing procedure must be approved by the national authority.

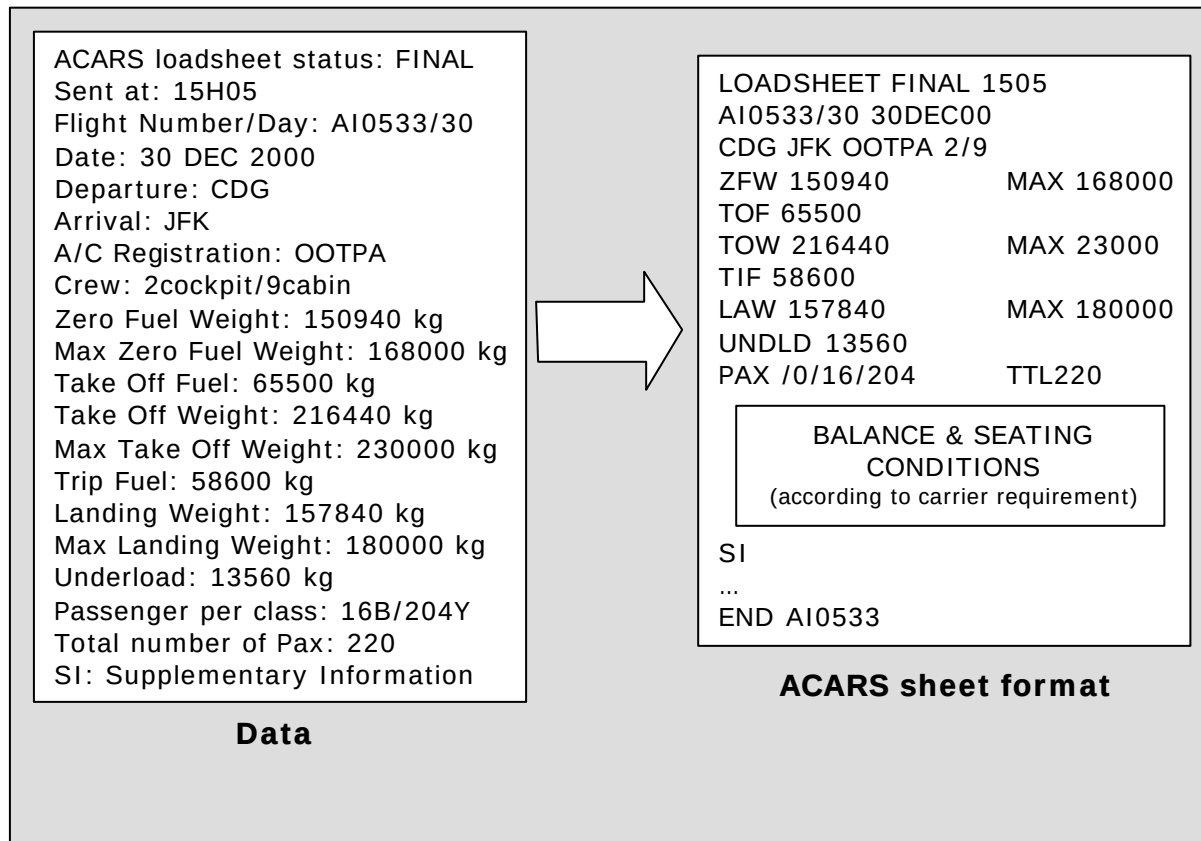


Figure 4.5:
Example of ACARS Loadsheet format

- **Take-Off Data Calculation (TODC)**

ATSU Remote AOC application (FMS) or Hosted AOC applications (customized)

Using data from the loadsheet and ATIS, the pilot can request and receive a Takeoff Data Calculation (TODC) from the ground performance system. After few seconds the crew receives an uplink with the speed figures and flap settings for the takeoff.

This calculation must take into account aircraft technical and environmental parameters embedded in the downlink request, such as:

- Aircraft type, version and tail specifics
- Actual airport, takeoff position, runway
- Actual TOW
- Status of aircraft systems that affect performance (wing and engine anti-ice, brakes, reversers etc)
- Meteorological conditions (wind data, OAT, QNH, Pressure Altitude...)
- Runway condition (water, ice...)

Together these parameters result in the correct flap settings; engine thrust ratings and takeoff speeds (V1, Vr, V2) for the actual takeoff weight.

Pilots usually obtain takeoff performance data through paper tables carried onboard. Using these tables requires from the crew to make some interpolations/corrections that imply margins, resulting in a non-optimum use of the actual aircraft performances.

Remark: even if the reliability of this application is good, it is possible to ensure data integrity by sending in a message the data in both numerical and alphabetical characters. For instance: " V1 = 162 kt (One-Six-Two) ".

It is to be noticed that even using ACARS transmissions to send data to the aircraft, the takeoff limitations are usually pre-calculated, and interpolations made to be closer to actual conditions.

Computerizing the TODC calculations and using a sophisticated aircraft performance software (without data interpolations) allows much more precise computations. Thus, it becomes possible to take-off with the optimum thrust settings, enabling higher payloads and reducing engine-operating costs.

This advantage is provided when using the *take-off computation module of the LPC on-board tool*.

Note: An AEEC Working Group (WG201) has just been created so as to work on the operational approval of safety related applications.

Request for TO DATA



Insertion of TO DATA

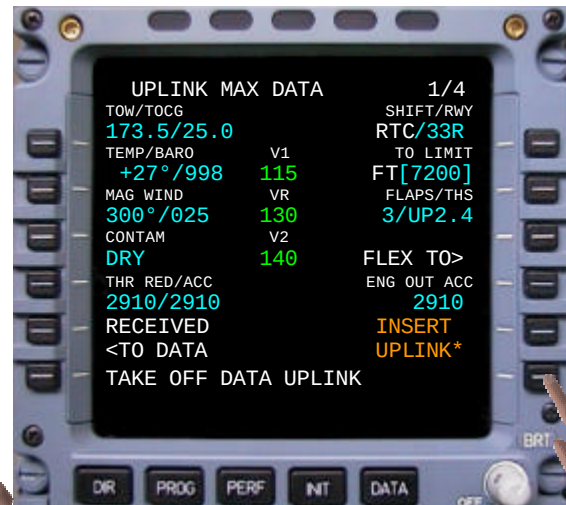


Figure 4.6
Example FMS ACARS TODC request screen

The pilot enters the input data for the TODC calculation (from ATIS). The downlink is sent to the ground TODC application, the calculation and optimization is made, and the uplink response is sent back to the cockpit. It can be printed if desired.

- **Delay Report**

ATSU Hosted AOC application (standard/ customized)

If the flight is delayed, a pilot can send a Departure Delay message to the flight operations department (including the reason and a new ETD). If necessary, the OCC must obtain a new departure slot and uplinks it to the cockpit. If the flight is delayed due to an ATC slot time restriction, the pilot can send an "All doors closed" message to OCC indicating that the flight is ready for departure and can accept an earlier slot time if offered.



Note:

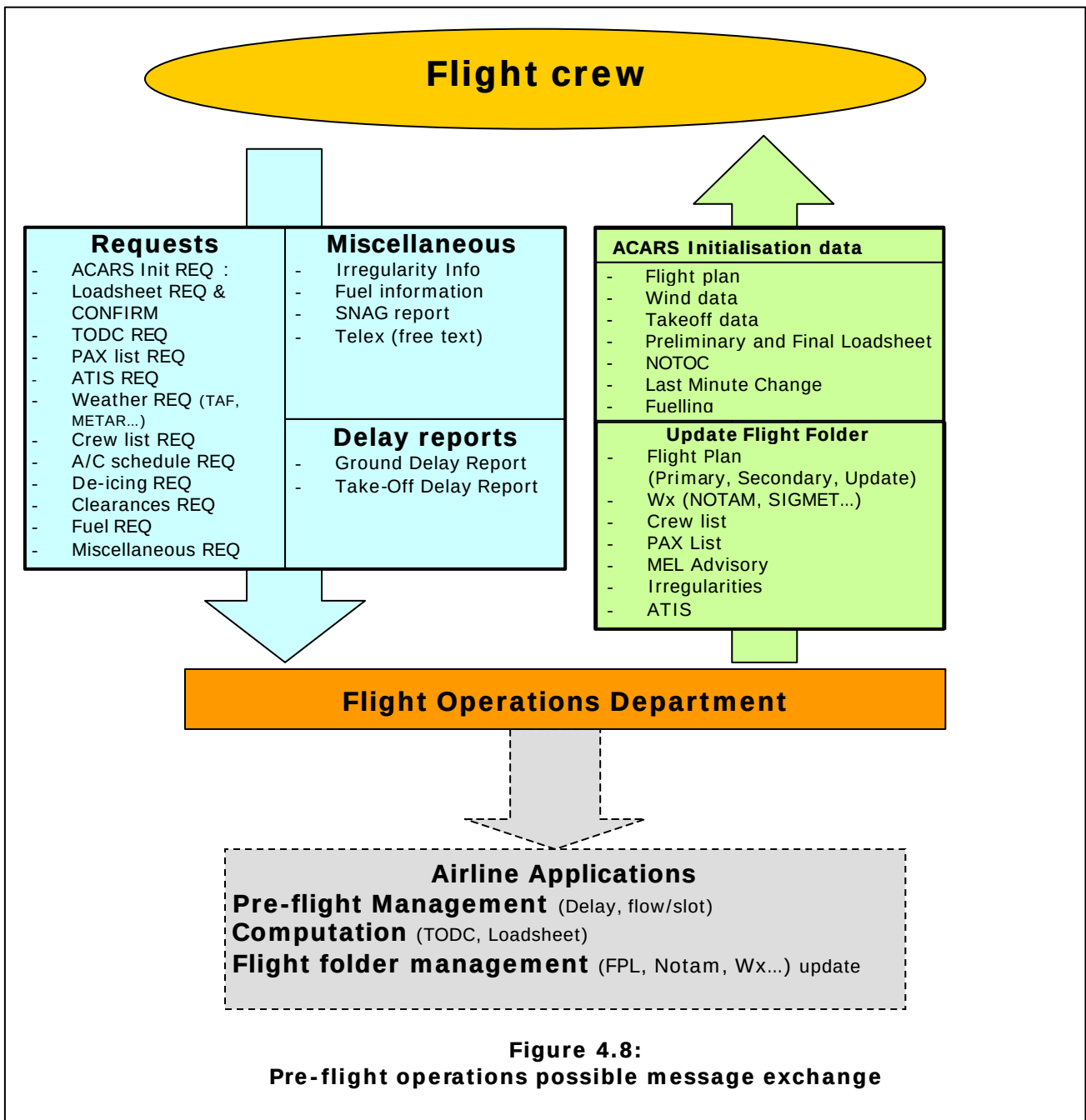
Other reasons can be added such as:

- W&B
- Ramp congestion
- Cargo
- Push Back
- Fuel
- Additional item

Figure 4.7
Example of departure delay report MCDU screen

- **Crew briefing:**

When the aircraft is not located on main base airport, it is possible to uplink to the crew textual flight briefings containing information relative to the scheduled flight. This can be simply done through an uplink free text message.



4.3.1.2. AIRLINE FLIGHT OPERATIONS - IN-FLIGHT

4.3.1.2.1. Pushback, Engine Start and Taxi

As soon as the parking brake is released the ACARS automatically sends an Out Report telling the flight operations that the flight is now "off-block". Therefore, there are no more needs for stations personnel or air traffic control to manually send a movement telegram.

Right before pushback, the Final Loadsheets is received from the load control center that performs load control for all departures. This gives the final load figures. If necessary a new TODC calculation is made based on this.

During taxiing ATC may offer or order a different runway or takeoff position than originally planned. The TODC application allows the pilot to quickly decide if a takeoff from that runway is possible and obtain the new takeoff data.

If there is a delay during taxi, e.g. due to de-icing or heavy traffic, the pilot sends a Takeoff Delay message to flight operations, including the delay reason and the expected takeoff time.



Figure 4.9:
MCDU Takeoff delay page

If the flight must return to the gate, a return-to-gate message is sent to the flight operations.

4.3.1.2.2. Takeoff and Climb

ATSU Hosted AOC application (standard/ customized)

The moment the aircraft lifts off the runway, ACARS automatically sends an "Off Report" to the flight operations, containing data such as the "Off time", along with the initial Estimated Time of Arrival, ETA (refer to §4.2.1).

4.3.1.2.3. Cruise

- Weather over ACARS
 ATSU Remote AOC application (FMS)

Wind data uplink

The ACARS allows requesting and receiving winds updates for:

- Climb (5 FL or altitudes)
- Cruise waypoint
 - . At up to 4 FL or altitudes for A340 & A320 Honeywell new FMS)
 - . At CRZ or STEP FL for A320 legacy & Thales new FMS
- Descent (5 FL or altitudes).

Each flight phase's WIND page includes its own **WIND REQUEST*** prompt, which means that wind requests and uplinks are made independently for each phase.

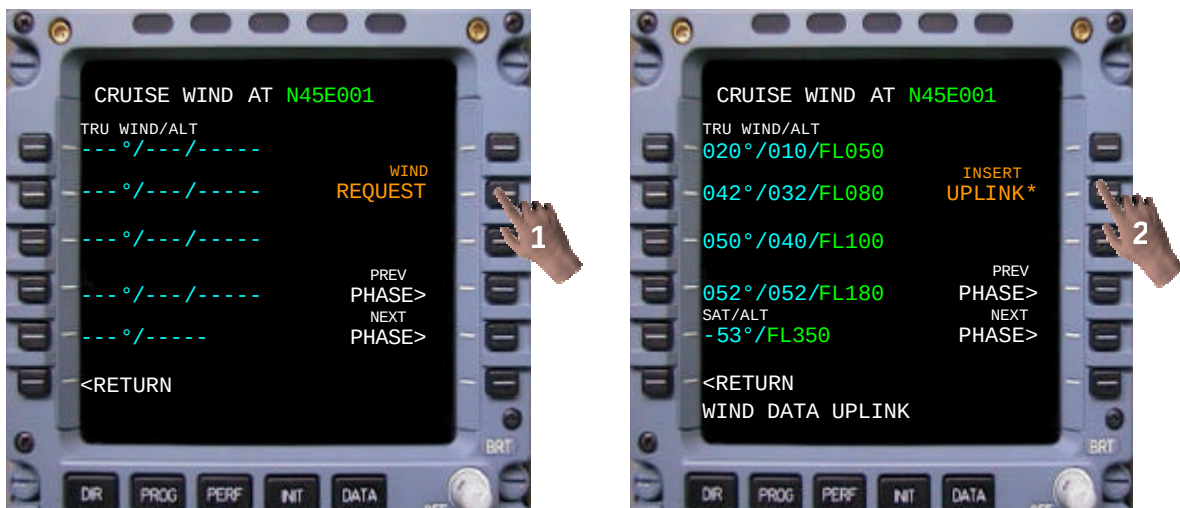


Figure 4.10:
AOC cruise winds and temperature

*Cruise winds for the active flight plan cruise waypoints can be requested using the **WIND REQUEST*** prompt on any cruise waypoint wind page*

*In response, the ground station can send winds for each of the cruise waypoints at up to 4 altitudes, and SAT at a single altitude. Received data can be reviewed prior to inserting. Inserting can be done using the **INSERT UPLINK*** prompt at any cruise waypoint: any previous wind entries at all cruise waypoints are overwritten.*

Airport weather

On the way to the destination, the pilot can at any time request, receive and print airport weather information (METAR, TAF...) over ACARS.

- **Meteorological report**

ATSU Hosted AOC application (customized)

The aircraft uses its DMU equipment for acquiring data related to weather observations, e.g. temperature, wind speeds, wind directions at various positions and flight levels. This feature is carried out by a number of airlines and data is forwarded to international meteorological centers as input to weather forecast models.

It is also possible for the pilot to send messages concerning the sky conditions or the turbulences encountered in-flight in order to inform its flight operation department or the ATC.

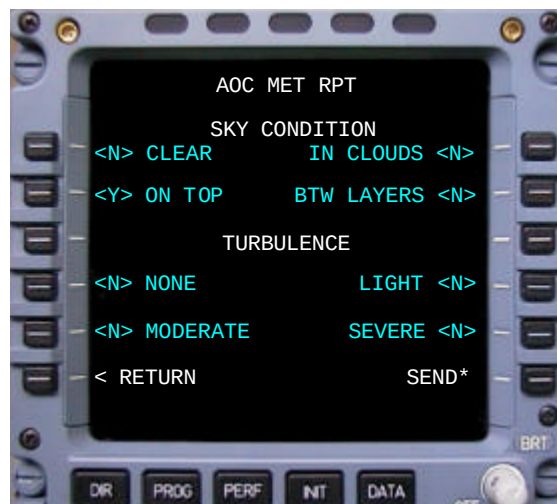


Figure 4.11:
Example of AOC MET report MCDU page

- **FMS position reports**

A position report downlink includes:

- Aircraft present position, UTC, altitude, temp, wind and fuel on board
- Current and next waypoint with their estimated times and altitudes

ATS waypoint position reports are sent automatically (refer §4.3.8.5).

ATSU Remote AOC application (FMS)

Company position reporting

ATSU Remote AOC application (FMS) or Hosted AOC application (customized)

It can be made:

- In response to a ground request from OCC where the aircraft position is plotted on a map display, or
- Automatically if requested via REQPOS uplink message, or
- Manually using the MCDU "SEND*" prompt.



Figure 4.12: Example of manually sent position report

- *ETA changes*

ATSU Hosted AOC application (standard or customized)

If there is a change in the calculated arrival time, an ETA report can be sent to the Flight Operations.



Figure 4.13: Example of ETA change MCDU page

- **En-route delay**

ATSU Hosted AOC application (standard or customized)

If there is a significant delay (e.g. a holding) the pilot sends an Enroute Delay including estimated approach time, ETA and delay code to OPUS.

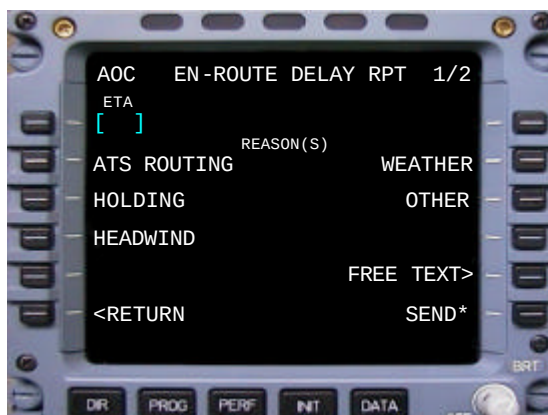


Figure 4.14: Example of Enroute delay report MCDU page

- *Free text telex (refer to §4.2.3)*

ATSU Hosted AOC application (standard or customized)

Throughout the flight the pilot is able to send several types of free text messages to communicate with various airlines' departments (Stations, Maintenance, Flight Ops...).

- **Flight plan**

Remote AOC application (FMS)

Flight plan updates or in-flight replanning can be requested to ground systems. The uplinked flight plan will be loaded as the FMS secondary flight plan, and then manually transferred by the pilot once checked.

A Flight plan summary (micro flight plan) can also be uplinked to the crew through free text and directly printed.

Note: the Dynamic Airborne Route Planning procedure (DARP) enables real-time aircraft rerouting based on updated meteorological information (refer to Appendix I).

- **Diversion Report**

ATSU Hosted AOC application (standard or customized)

When a diversion to an alternate airport occurs for any reason (e.g. weather, medical, technical, fuel), a Diversion Report is sent by the crew to the flight operations. The Diversion Report may contain information about the new destination, the ETA, the reasons (FOB, technical, security, medical...)

In response to this message a new flight plan can be uplinked to the aircraft (as described here above).



Figure 4.15:
Example of Pilot's Diversion page on the MCDU.

4.3.1.2.4. Descent, Approach and Landing

- *Landing Data Calculation (LDC) over ACARS*

ATSU Hosted AOC application (customized)

Landing data calculation (speeds and flaps settings) can be obtained in the same way as TODC (refer to §4.3.1.1).

- *In-Range Report*

ATSU Hosted AOC application (customized)

At the beginning of descent, a so-called “In-Range Report” can be automatically sent to various departments on-ground to inform that the aircraft is to arrive. Furthermore, information is retrieved from ground systems and uplinked in connection with arrival:

- Irregularity Information
- Arrival information: terminal, gate, baggage handling, etc
- Connecting flight information for the passengers
- Passenger re-bookings
- Next leg data for the aircraft itself
- Crew next duty
- ...

- *Approach report:*

ATSU Hosted AOC application (customized)

Once on approach, another automatic downlink is sent to advise the airport systems and stations personnel that the aircraft will shortly be landing. Gate personnel and technicians will be dispatched to meet the aircraft at the gate on time.

On touchdown the ACARS can automatically send an On Report to the Flight Operations (that can forward it to appropriate services such as ground handling).

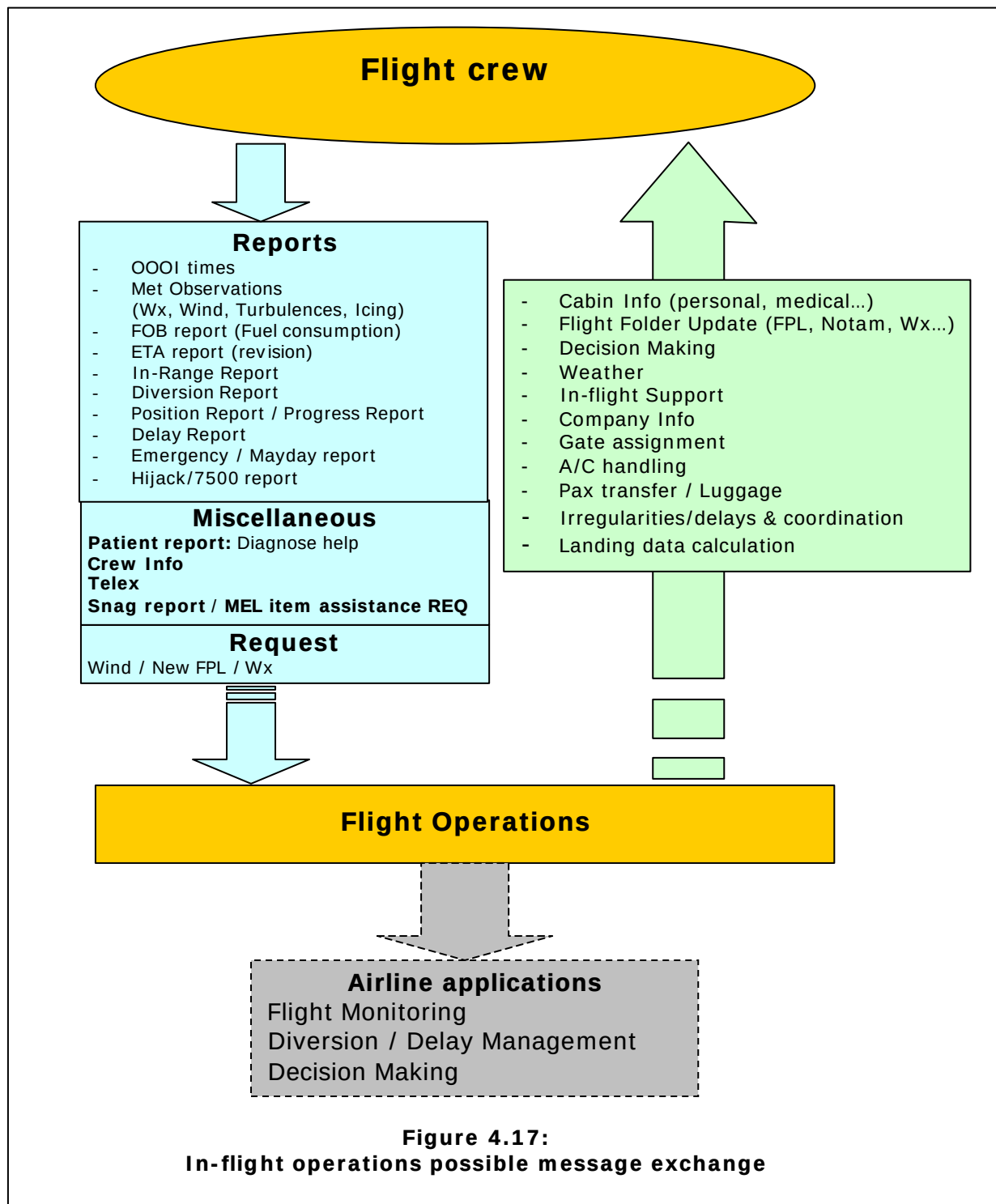
4.3.1.2.5. Taxiing and Parking

If there is a delay during taxi in, e.g. the gate is occupied or unmanned, the pilot sends a Gate Delay report to the Flight Operations.

After parking the ACARS can automatically send an “In report” to the Flight Operations.



Figure 4.16:
Example of Gate delay report



4.3.1.3. AIRLINE FLIGHT OPERATIONS - POST-FLIGHT

After the flight completion, some of the document the crew must fill can be transmitted to the airline through ACARS; for instance, the journey log, the flight summary. Data such as crew list, functions, OOOI and Fuel information (mass at Takeoff, used, loaded) can be embedded in these reports.

Other information, such as the landing type and flight times, can also be downlinked for information/statistics.

It is to be noticed that fuel can be requested via datalink (refer to §4.3.5.2).



Figure 4.18:
ACARS datalink general architecture

FOQA (Flight Operation Quality Assurance)

Also referred to as Operational Flight Data Monitoring (OFDM), Flight Operations Quality Assurance (FOQA) is the exploitation of flight data to enhance flight safety. Data from an aircraft are analyzed to identify any exceedance and deviations of important flight parameters from normal operating ranges.

The data processed by flight analysis software are downloaded from the QAR (Quick Access Recorder) onboard the aircraft. The traditional way to download these data is manually, using a disk.

Using datalink to transfer automatically the QAR data to the ground will result in timesaving. For instance, when the aircraft has a ground stop at an airport equipped with wideband datalink (such as Gatelink), the opportunity can be taken to download ACMS and QAR data for FOQA and maintenance analysis.

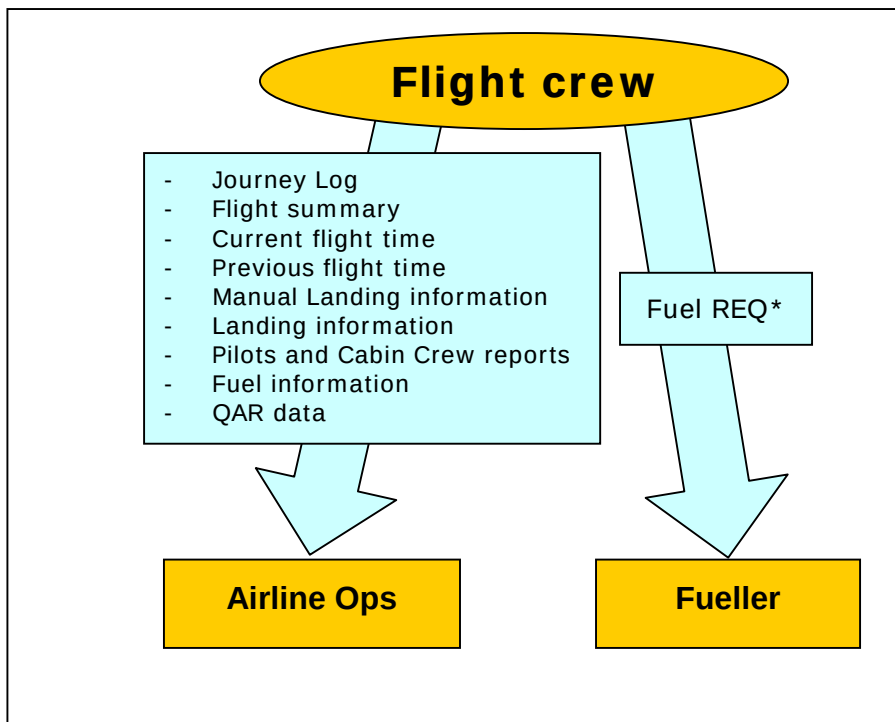


Figure 4.19:
Post-flight operations possible message exchange

4.3.2. AIRLINE MAINTENANCE

Datalink also contributes to the maintenance and support needs of the mission. When coupled with a central maintenance system and DMU (as described in §3.2.2), it supports the downlinking of aircraft systems status, diagnostic information and engine data and therefore optimizes the treatment of unscheduled maintenance events.

This functionality can greatly improve the efficiency of maintenance support. For example, with downlinked maintenance data in real time, the ground support team can become aware of in-flight problems and more effectively and efficiently prepare for maintenance needs prior to aircraft arrival. Identification of a deteriorating system will allow a fault to be rectified before it becomes visible to the pilot or avoid an increase of the turn around time.

In addition, downlinked engine data, or other system data, can be used for engine trend monitoring without requiring maintenance personnel to periodically download information directly from the airplane for ground analysis

This implies:

- **A reduction in number and length of aircraft delays**
- **A reduction of line maintenance workload (due to a better anticipation)**
- **Maximization of the time available for appropriate maintenance actions to be determined and preparations to be made.**

Therefore, by analyzing an aircraft's fault history and consequently identifying and prioritizing preventive maintenance actions, pilot reports and departure delays are minimized.

Different systems can be used to downlink these data: on-board avionics (DMU, CMS/CFDS) or customized AOC pages, manually filled by the pilot. These last do not contain as many information as the avionics messages but are more readable. Examples of data that can be integrated in these messages are provided figure 4.21.

4.3.2.1. AIRLINE MAINTENANCE - PRE-FLIGHT ATSU Hosted AOC application (customized)

If a flight must be dispatched with malfunctions or inoperative equipments (according to regulations), the crew can request assistance to the maintenance department so as to be in accordance with the aircraft's MEL. A MEL message, which is a written statement from the maintenance, can be sent by telex directly to the cockpit printer before taking-off, ensuring that the flight is correctly dispatched.

This results in timesaving; it is even truer when operating on airports where the airline does not have its own technicians.

4.3.2.2. AIRLINE MAINTENANCE – IN-FLIGHT

4.3.2.2.1. DMU reports

ATSU Remote AOC application (DMU)

The **ACARS function / AIDS-ACMS** interface provides the capability to transmit to the ground reports for the following applications:

- **Aircraft performance monitoring**
- **Engine condition monitoring**
- **APU health monitoring**

The table underneath shows how reports can be used to monitor aircraft engines/APU.

Applications	Reports
Aircraft Performance Monitoring	Aircraft Cruise Performance Report
Engine Trend Monitoring	Engine Take-Off Report Engine Cruise Report Engine Trim Balance (A330/A340 only) Engine Divergence Report
Engine Exceedance Monitoring	Engine Start Report Engine Gas Path Advisory Report Engine Mechanical Advisory Report
Engine Trouble Shooting	Engine Run up Report Engine On Request Report
APU Monitoring	APU Main Engine Start/APU idle Report APU Shutdown Report
Miscellaneous Monitoring Functions	Hard Landing/Structural Load Report Environmental Control System Report Ram Air Turbine Test Report (A330/A340 only)
Long-term trending analysis	Engine cruise report Cruise performance report Engine take-off report Engine start report APU MES/IDLE report Engine Trim Balance (A330/A340 only)
Line maintenance for engine troubleshooting (at run-up or during the flight).	Engine run up report Engine report on request
Trending or maintenance purpose	Ram Air Turbine reports

Note: When the following reports are automatically triggered, **maintenance and investigative actions** are required.

- o Engine gas path advisory report
- o Engine mechanical advisory report
- o Engine divergence report
- o APU shut down report
- o Load report
- o ECS report

All the reports can be printed or sent via ACARS at any moment of the flight through the MCDU menu. The DMU can be programmed to send auto-triggered reports at the time of generation or at the end of the flight (refer to §5.3.6). The output rule for the reports can be defined using the ground-programming tool.

Operational example:

Uplink request for the Engine On Request Report can be used to obtain a general status of important engine parameters during the flight in case of ETOPS.

4.3.2.2.2. CMS/CFDS reports
ATSU Remote AOC application (CMS/CFDS)

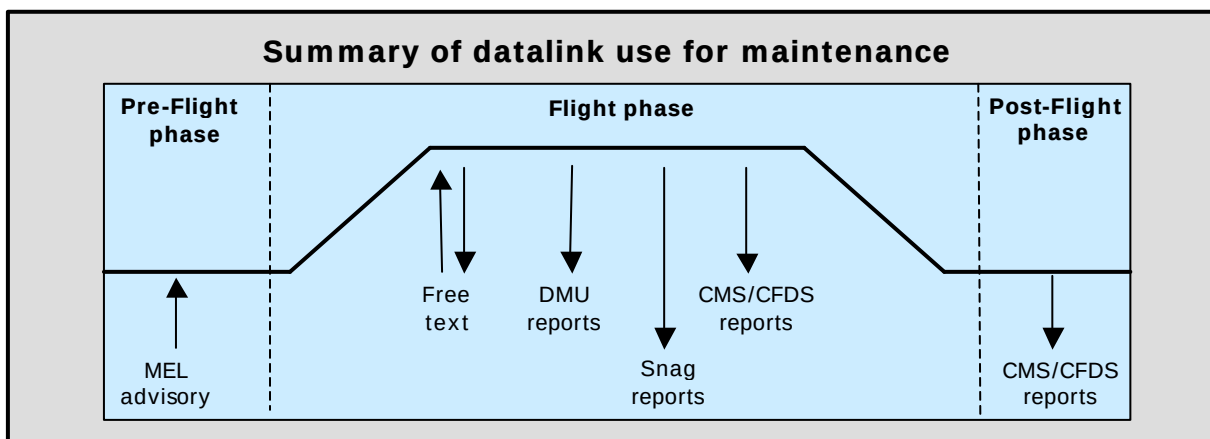
The ACARS function / CFDS-CMS interface makes it possible to downlink the following data, to **monitor the aircraft and prepare maintenance actions**:

- *ECAM warnings and failure messages*
- *Post Flight Report (PFR) or Current Flight Report (CFR)*
This report contains the ECAM warnings displayed to the crew, and the corresponding failure detected by the systems' BITE. An example of PFR is provided in figure 4.20.
- *Previous Flight Reports*
Manual downlink only, on the ground of ECAM and failure messages recorded during the previous 63 flight legs.
- *BITE report (e.g. Trouble shooting data)* concerning individual systems' BITE. Manual downlink or upon uplink request from the ground only (option)
- *Class 3 reports*
Class 3 failure messages detected during last flight leg.
- *Servicing Report (CMC Option package)*
Report including parameters, which need periodic checks, and servicing actions (e.g. oil levels, filter status, tyre pressure...)
- *Avionics Configuration Reports (CMC Option package)*
(Equipment Configuration Report / Diskettes Configuration Report / Configuration Change Report), list of equipment: P/Ns, S/Ns, FINs...

Note: Information on the different settings/options available to activate each message is provided in §5.3.5 and §5.4.3.

A/C IDENT F- GGEA DATE MAR31 FLT NBR ITF1027 FROM / TO LFPO/LFBT ENG ON/OFF 1015 /1720		MAINTENANCE POST (or CURRENT) FLIGHT REPORT LEG 00		CMC1 PRINTING PAGE 01/01 DATE APR02 UTC 1406
3 COCKPIT EFFECTS	UTC FLIGHT PHASE	3 FAULTS		
ATA 36-11 ENG 3 BLEED FAULT	1023 TAKEOFF ROLL	ATA 36-11-43 CLASS 1 INTERMITTENT FAN AIR V(12H43)		SOURCE BMC 3 IDENTIFIERS ZC EIVM U3
ATA 30-11 ANTI ICE F/O PROBE	1033 CLIMB	ATA 30-11-16 CLASS 1 HARD R STATIC PROBE(8DA2)/ PHC2(6DA2)		SOURCE PHC 2 IDENTIFIERS ADIRU1 A DIRU2 ADIRU3
ATA 22-00 AUTO FLT AP OFF	1558 CRUISE	ATA 34-12-34 CLASS 1 HARD ADIRU1(1FP1)		SOURCE AFS
END OF REPORT or CONTINUED(if more than 1 page)				

Figure 4.20: Example of Post Flight Report (PFR)



4.3.2.2.3. Manually sent reports

ATSU Hosted AOC application (customized)

The ATSU AOC software enables many reports to be customized.

The data that are regularly sent through customized MCDU pages, and addressed to maintenance department, mainly concern engines, fuel and oil.

Among the main ones are the followings:

- N1 - fan speed - %
- N2 - compressor speed - %
- EGT - exhaust gas temp.
- EPR - engine pressure ratio
- FF - fuel flow/hour
- C - fuel consumption
- TRA - throttle angle
- FOB - fuel on board
- VIB – vibration
- OP - oil pressure
- OILT - oil temp
- OILQ - oil quantity



Figure 4.21:
Example of AOC Engine Data Report

4.3.2.3. MAINTENANCE GROUND TOOL: AIRBUS' AIRMAN GLOBAL SOLUTION

In order to optimize the treatment of unscheduled maintenance events Airbus offers its customers a new tool called Airman. This ground-based software is dedicated to the identification and management of unscheduled maintenance.

AIRMAN receives and analyses the aircraft status information generated by the On-board Maintenance System. The information is automatically transmitted to the ground by the aircraft's communication system (ACARS for the time being). This tool also handles logbook and maintenance action reports. These information sources are synthesized, combined with AIRBUS' and the airline's own technical documentation and presented through a user-friendly interface.

Aircraft status information is sent to AIRMAN while the aircraft is either in-flight or on-ground. Message analysis also takes place in real-time. These capabilities maximize the time available for appropriate maintenance actions to be determined and preparations to be made.

AIRMAN is also capable of analyzing an aircraft's fault history and consequently identifying and prioritizing preventive maintenance actions. This feature is designed to minimize Pilot reports and consequently departure delays.

Functions

The AIRMAN tool serves three principle areas of activity within the airline:

- Gate maintenance (fault identification and management)
- Hangar maintenance (preventative maintenance identification and prioritization)
- Engineering services (line and hangar maintenance support)

Capabilities

- To support these functions AIRMAN has a wide variety of powerful capabilities:
- Real-time aircraft data capture and analysis
- Logbook and Maintenance report acquisition
- Experience recording and replay
- Links to Airbus technical data viewers
- Standard interface to allow integration with airline's IT system
- Customization and revision

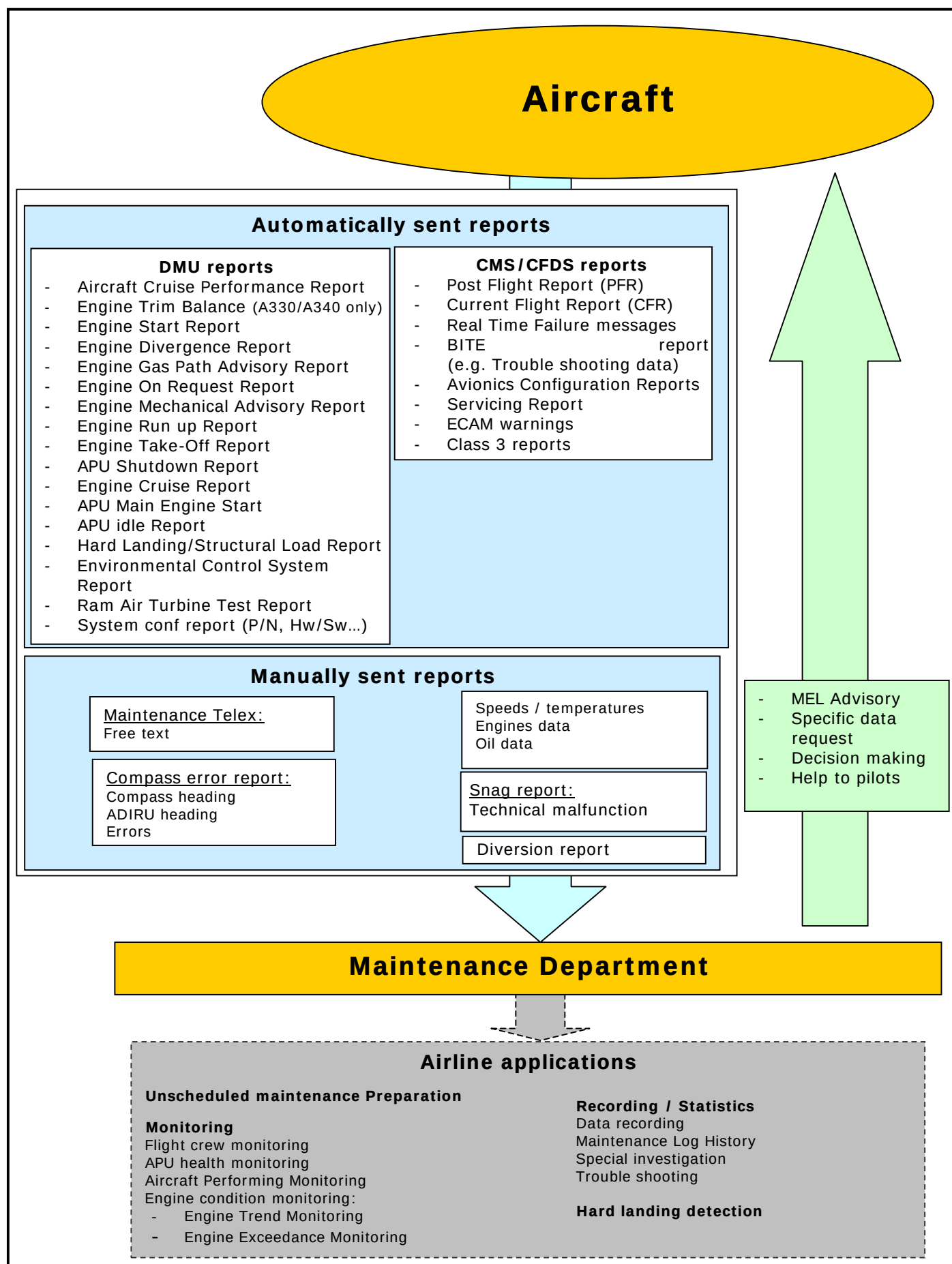
AIRMAN's data analysis, synthesis and presentation provides:

- Simpler, more effective troubleshooting,
- Preventive maintenance recommendations,
- More effective engineering support.

The result is:

- Improved aircraft dispatch reliability,
- Reduced operational cost,
- Reduced maintenance cost.

Introduction to AIRMAN 2002 Package (functional diagram, software functional description, possible configurations, etc...) is provided in Appendix J.



4.3.3. CREW MANAGEMENT

In addition to the monthly crew planning, crew management is involved in real-time tactical tasks such as crew re-assignment or schedule changes. Datalink can be a good way to improve crew monitoring and decision making in crew assignment.

Crew duty time, OOOI (refer to §4.2.1), delay information and other reports can be transmitted to the ground via ACARS to enable delay management and manpower optimization in case of unforeseen situation. Thus, the airline crew department is able to send to the aircraft information on re-scheduling, crew next duty or other duty time alert. It is also possible to uplink updated crew lists (different from those transmitted to the pilot/purser during the pre-departure briefing).

- **Delay management**

- **ATSU Hosted AOC application (customized)**

- Changes to crew schedules can be uplinked to the aircraft.
 - Shortly before landing a Crew Next Duty message can be sent to the aircraft, listing the next duty details for each crewmember (flight number, A/C type and registration, STD, ETD, gate, etc). Each crewmember knows where to go and what to do immediately after landing.
 - The Captain and Purser can also receive updated or Next Crew list.

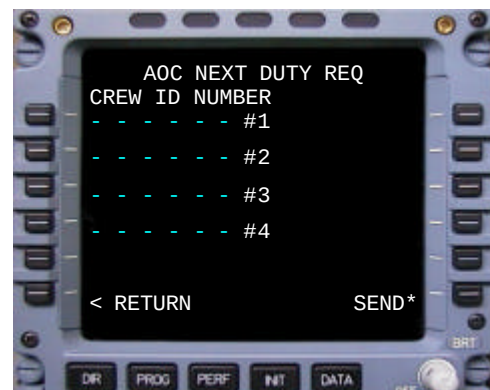


Figure 4.22:
Example of “Crew next duty” request

Flight time can also be monitored in real-time in order to generate warnings (in case duty time is expected to exceed regulation).

- **Pay computation**

- **ATSU Hosted AOC application (standard or customized)**

Concerning more administrative tasks (such as pay computation), datalink is being seen as an improvement as based on exact values and processed using dedicated software.

Thus, crew allowances may be calculated by using electronics data directly transcribed from received ACARS messages (avoiding manual transcription of written data). Downlinked data (such as OOOI or Journey log) can be used to compute time away from base, night duties, block hours, domestic or international flights, training flights or duties, compensatory days off.

- **Diversion report**

- **ATSU Hosted AOC application (standard / customized)**

In case of diversion or flight schedule changes, new destination layover data (hotel, transportation, pickup times) can be transmitted to the crew in free text format.

- **Records & statistics**

- Hosted AOC application (customized)

Thanks to downlinked information, the crew management department can also automatically build statistics and track crew exposure to cosmic radiation, flight/duty times or average fuel consumption per pilot, etc.



Crew records can be updated automatically; for instance, Autoland information (such as Crew duty, landing Cat, RVR, RWY Id) can be transmitted to keep pilots databases up-to-date and generate warning reports (training, license...). Downloaded data from the QAR used for Flight Operations Quality Assurance (refer to §4.3.1.3) can also be used to update records and build statistics.

Figure 4.23:
Example of AOC landing report

Note: Some national authorities require these data to be archived.

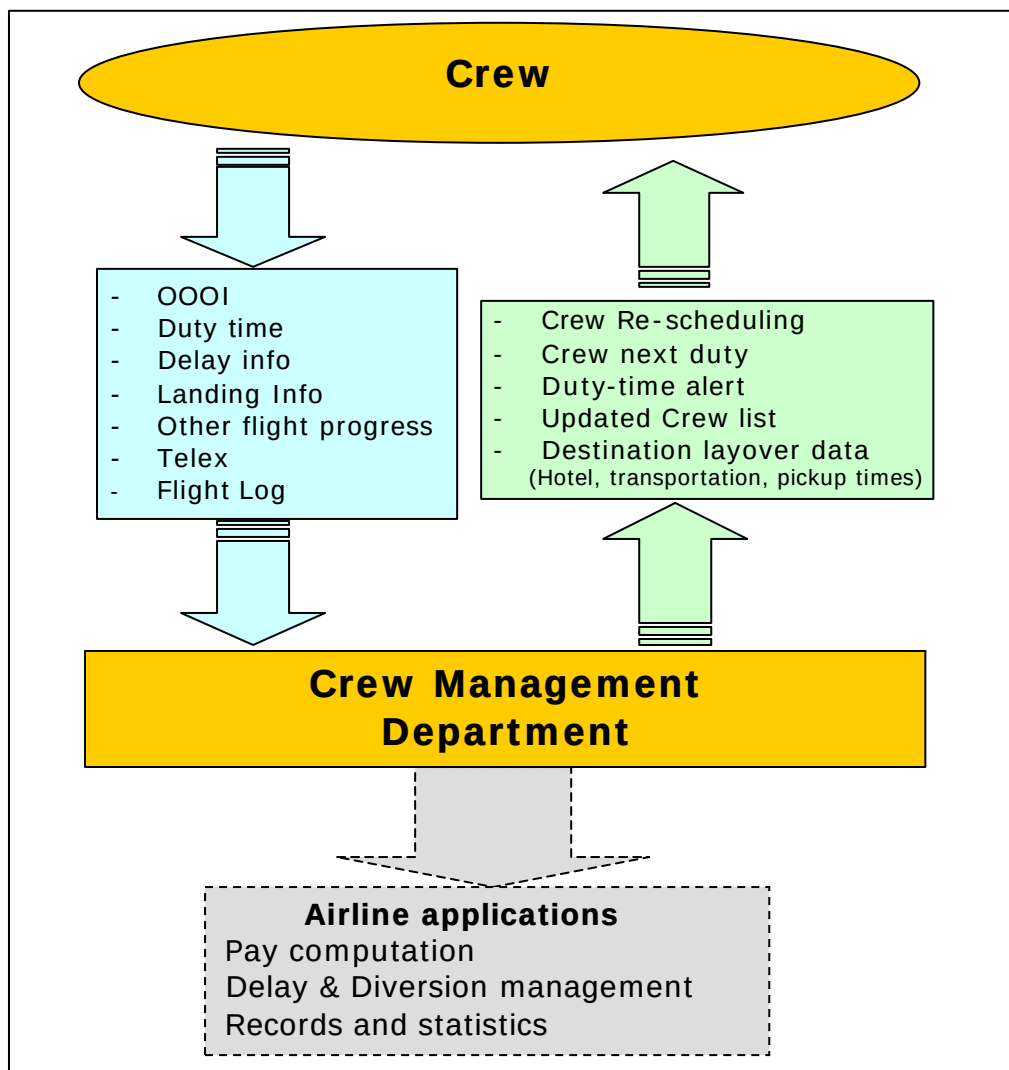


Figure 4.24:
Crew management possible message exchange

4.3.4. CABIN CREW

ATSU Remote AOC applications (Cabin terminal)

To ensure proper cabin operations, the cabin crew can find in datalink an helpful asset. Information concerning the cabin or the passengers along with the ground handling coordination can be transmitted via datalink.

For instance, the cabin technical status, engineering defects or any emergency equipment irregularities or malfunctions can be transmitted in real-time to the airline maintenance in order to be quickly replaced so as not to impact the aircraft dispatch.

Datalink also enables to ensure efficient communication with ground staff (catering or cleaning). In case of modification of the on-board passengers numbers or specificities, new flight meals (or other catering loads) can be ordered and loaded onboard the aircraft.

To the Cabin Management Terminal (CMT) in the galley area (if installed), the following information can be sent:

- An updated Crew List
- A Cabin Information List (passenger list, route & destination info)
- Credit card authorization
- Wheel chair request
- On-board sells status
- ...

Concerning the administrative tasks of the purser, the cabin Log Book can be transmitted directly to the airline at the end of flight legs (using non-ACARS datalink, refer §3.3).

From the departure station, it is possible to uplink information concerning passengers, in case their baggage was not loaded onboard, due to a short connection for instance.

Messages to individual passengers are printed and delivered by hand.

If the departure and takeoff was significantly delayed, the stations system also sends a preliminary update about passengers that have missed their original connections and therefore have already been re-booked at this stage.

Passenger medical problems can be reported and advice obtained from the ground (refer to figure 4.25). This can avoid a diversion and all related issues.

If flight medical incidents happen for 1 per 11000 passengers only (according to British Airways statistics, 2000), managing these emergencies on-board is crucial and can limit delays and costly medical diversions.

Cabin crew is given the knowledge and skills to recognize and manage basic in-flight incidents. If immediate medical assistance is needed, support can be obtained from ground to take decision. In these cases, datalink can be very useful to exchange information and send patient report.

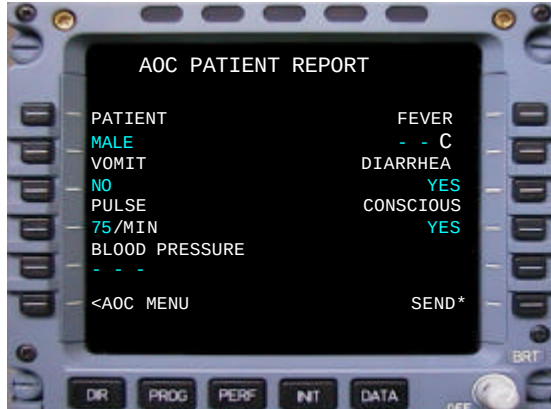


Figure 4.25:
Example of medical report

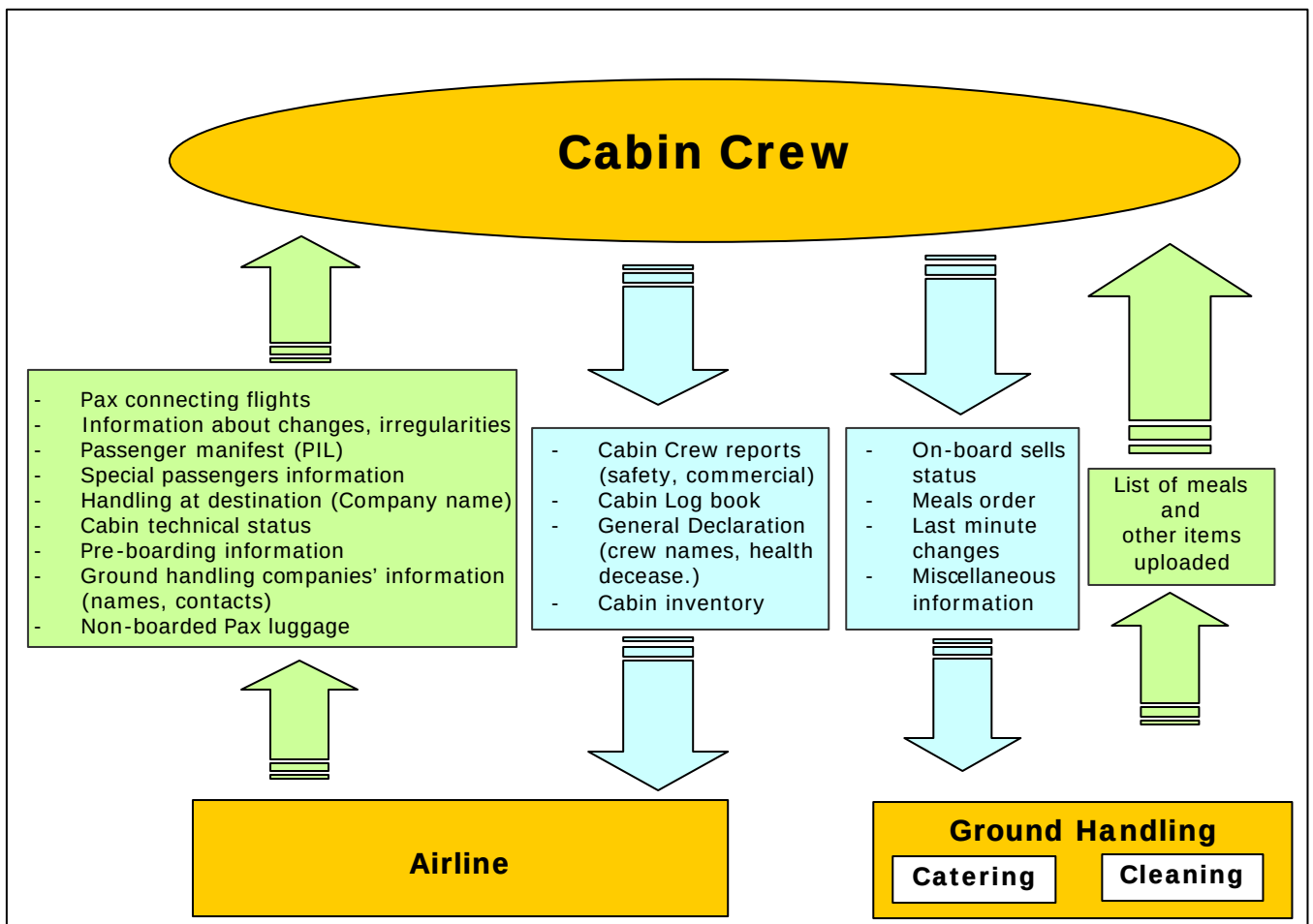


Figure 4.26:
Cabin crew possible message exchange

4.3.5. AIRCRAFT GROUND HANDLING

4.3.5.1. AT STATION

4.3.5.1.1. Departure

ATSU Hosted AOC application (customized)

- Before departure, the updated check-in passenger list is transmitted to the crew.
- Information relative to boarding status, the missing and connecting Pax, can be uplinked to the aircraft. Estimated time of departure can thus be modified and a new slot requested.
- Other information can be transmitted to the aircraft such as luggage that has not been loaded on-board.

4.3.5.1.2. Before landing information exchanges

ATSU Hosted AOC application (customized)

- Shortly before landing, a message can be automatically sent through datalink to inform the station that the flight is to land within a certain time (so-called "In-range report" – IRR).
- It is also possible for the pilot to request assistance for passengers, other miscellaneous requests or information through telex. Once received, the station prepares all the actions in connection with the aircraft arrival.
- Delay messages are sent to flight operations but also to the station.
- Information concerning the aircraft handling (delays...) at the destination airport is also possible from the station.

The communication skill and data exchanges between the aircraft and the station results in an optimization of time-sharing between all the activities linked to passengers and aircraft services on ground.

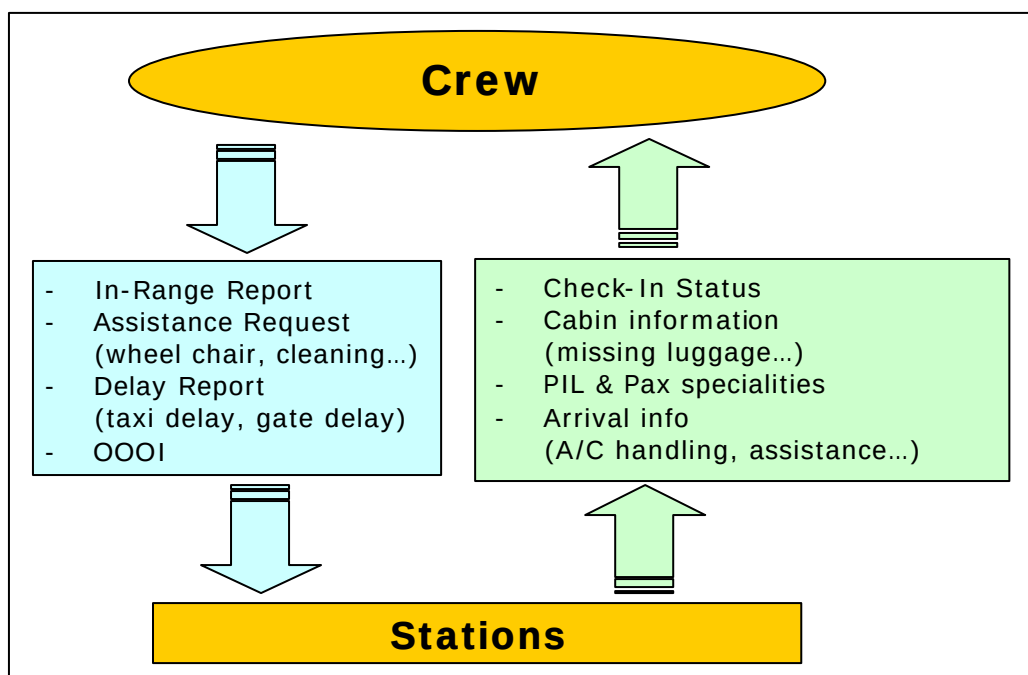


Figure 4.27:
Crew / Ground handling possible message exchange

4.3.5.2. FUELLER

ATSU Hosted AOC application (customized)

Fuel can be ordered before landing or at the gate and a receipt directly delivered to flight crew after uplifting. All these exchanges of information can be supported by datalink communications. This enables time and crew workload savings, which is crucial when operating shuttle flights with small turn-around.

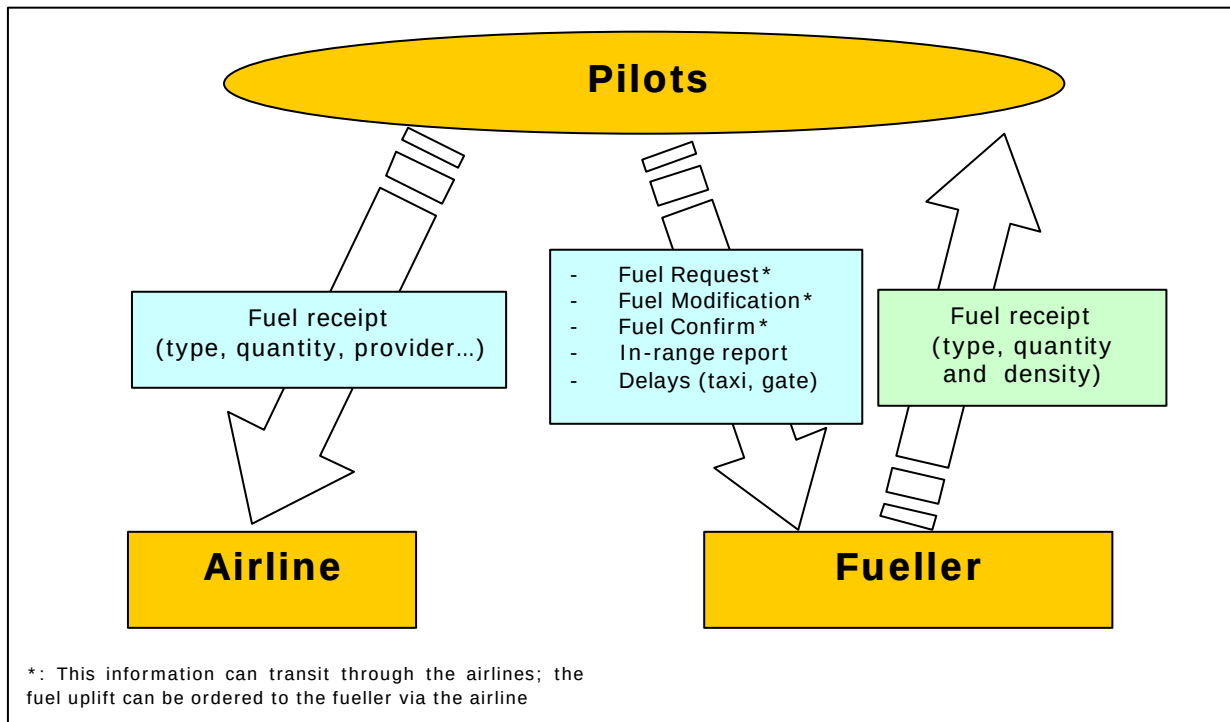


Figure 4.28:
Crew / Fueller possible message exchange

Fueling can be requested and confirmed via ACARS. A Fuel report is downlinked after fueling completion to ensure a follow-up with fuel providers.



Figure 4.29:
Example of fuel uplift request

4.3.5.3. DE/ANTI-ICING

ATSU Hosted AOC application (customized)

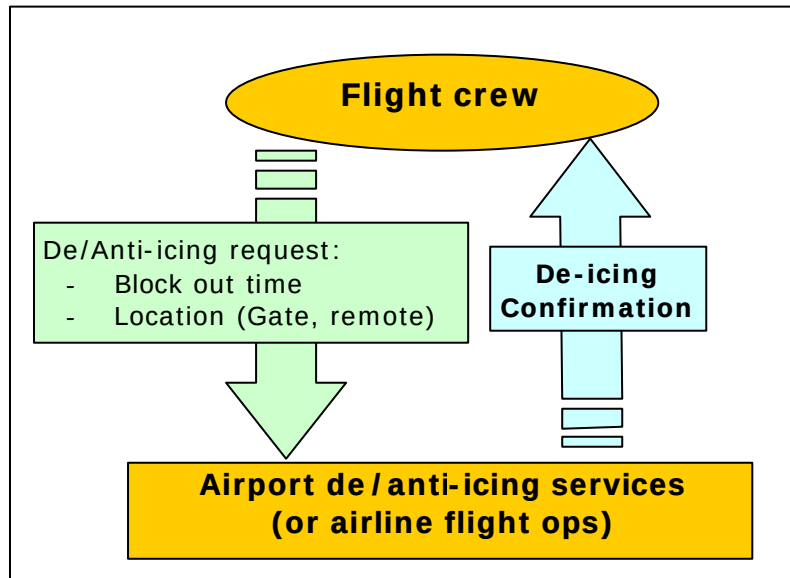


Figure 4.30:
Crew / De/Anti-icing services possible message exchange

If the crew decides that de-icing must be completed, they can directly request it to the airport de-icing services (or via its flight operations) from the aircraft through datalink, via MCDU dedicated pages. This reduces the crew workload just before take-off and enables pilots to deal with other activities (such as flight preparation or check-list completions). Again, use of datalink results in timesaving.



Figure 4.31:
Example of de-icing request

The pilot may request **de/anti-icing**. The ground de/anti-icing application will uplink a confirmation and **information about the de/anti-icing location and time**. After the anti-icing has been completed, an uplink message will confirm **the type of fluid and hold over time**.

4.3.5.4. CATERING

Refer to figure 4.26.

4.3.6. PASSENGERS

With the increasing available data rates, datalink will more and more impact passengers during a flight.

Passengers are expected to use upcoming wideband satellite datalink (refer §6.2.3.4) for: E-mail, access to the Web corporate networks, transfer of large files (audio and video images), e-commerce transactions along with Internet, mobile phone, WLAN.

The implementation of such **not ACARS-based** services (refer §3.3) has already started but remains limited due to the limited communication network capacity and datarate. DSP and telecommunication service providers (such as Inmarsat) are expected to increase their service offers within the coming.

Concerning passengers trip, it is possible to receive through ACARS and display on a screen (Airshow) many information concerning:

- Destination information, including gate numbers for connecting flights
- Graphical display of the airport layout, parking gate and gates for connecting flights (refer to §3.2.5).
- Rebooking and traffic irregularity information

Thus, the passengers will step off the plane well informed about airport procedures, layout and their connecting flights.

4.3.7. OTHER AIRCRAFT: AIR-AIR TELEX

ATSU Hosted AOC application (customized)

If pilots wish to communicate with other airlines' flight, it is possible for them to send ACARS freetext messages. The flight number specified by pilot enables to route messages to appropriate aircraft (if function implemented on ground).

Those messages are used to send MET data or miscellaneous information to other aircraft.

4.3.8. ATC

4.3.8.1. DEPARTURE SLOT AND CLEARANCES

4.3.8.1.1. Departure slot

ATSU Hosted AOC application (customized)

The flight operations can uplink to the cockpit via ACARS the *Departure slot* and *CTOT* (Calculated Take-Off Time). These flow messages can be printed or displayed on the MCDU and are acknowledged by the pilot via a datalink message (if required).

4.3.8.1.2. (Pre-) Departure Clearance

ATSU Hosted AOC application (customized) or Hosted ATC applications

The traditional way to obtain this clearance is for the pilot to request the clearance on a special frequency on the voice radio. A pilot can now request a (Pre-) Departure Clearance via datalink in A623 format, on more and more airports (if ATC equipped). The clearance is uplinked to the aircraft when the ATC system has processed it; the pilot acknowledges it electronically.

On FANS A+ equipped aircraft, these clearances are displayed/answered on the DCDUs.

```
1**DPTR CLRNC**
FLT 902-13 SFO – JFK UAL902 SFO B/A340/G P2015 RQ370
XPDR 3627
MAINT FL230 EXP REQ ALT 10 MIN AFT T/O
GND CTL FREQ 121.8
/DPTR CTL SEE SID
DO NOT EXCEED 250 KTS TIL ADVISED
-SFO6 S SFO SAC J32 BAM- SFO SFO6 SFO
SAC./JFK
```

ACARS printed DCL



Figure 4.32:
Example of DCL request on DCDU (FANS A+ option)

Pushback and startup clearances along with taxi clearance can also be requested and obtained from ATC (if equipped).

Advantages of datalink procedures over the voice procedures

- **Clear printout** of the clearance
- No **language** problems
- Voice radio **quality** issues
- **No congested**/saturated frequencies
- Does not need full attention of both persons at the same time; clearances processed by both pilot and the controller at “their leisure”.

4.3.8.2. OCEANIC CLEARANCE

ATSU Hosted AOC application (customized) or Hosted ATC applications

Oceanic clearance over ACARS

When an aircraft is to enter North-Atlantic oceanic airspace, it must have an Oceanic Clearance (OCL).

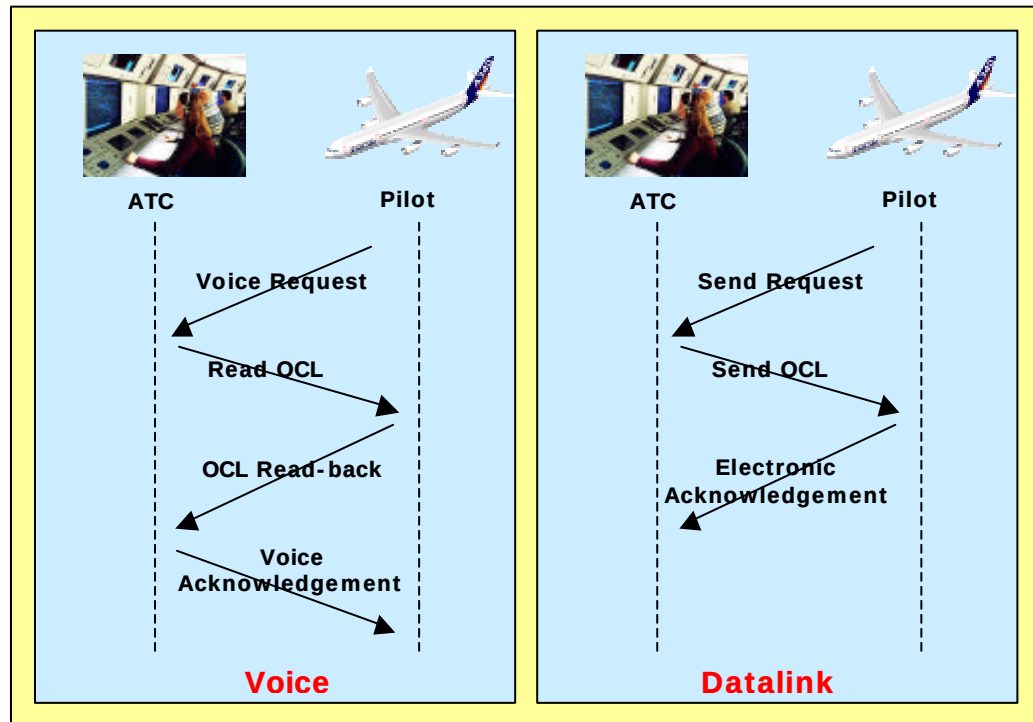


Figure 4.33: Voice and Datalink-based oceanic clearances

The traditional way to get this clearance is over voice radio (refer figure 4.33), but instead, it can be delivered over ACARS. The pilot gets a printout of the message. If the latest industry standards (AEEC 623) have been implemented by the ATC center, the pilot does not have to read back the message and only an electronic acknowledgement is needed.

On FANS A+ equipped aircraft, the OCL is displayed on the DCDUs (figure 4.34) and can be printed.



Figure 4.34:
Example of Oceanic Clearance with FANS A+ package

4.3.8.3. D-ATIS

ATSU Hosted AOC application (standard) or Hosted ATC application

4.3.8.3.1. Definition

The ATIS (Automatic Terminal Information Service) is an information about the airport (takeoff/landing procedures, frequency and MET conditions...) that a pilot needs for takeoff and landing. Traditionally, ATIS messages are broadcasted by each airport on a special frequency as a continuous voice transmission. Now, ATIS is becoming available over datalink at more and more airports (see below).

Note: ATIS over datalink is called Digital-ATIS (D-ATIS).

Examples of D-ATIS from San Francisco Airport

2 .N648UA RA L SFO ATIS INFO K 0150Z.
 16004KT 10SM OVC250 13/06 A3033. SIMO CVA IN USE. ARRIVALS EXPECT RWYS 28L, 28R.
 DEPG RWYS 1L, 1R. NOTAMS... ONE HUNDRED SIXTY-FIVE FOOT HIGH PILE RIVER OPERATING
 NORTH OF RWY 28R NEAR TAXIWAY KILOADVS you have INFO K.

4.3.8.3.2. D-ATIS benefits:

Advantages

- ° The Aircrew no longer needs to find an open voice channel and manually transcribe routine information.
- ° Pilots can download, save and update D-ATIS messages at any time during the flight, saves time during a period of high workload in the cockpit.
- ° It is available regardless of the airplane's distance from the airport, whereas voice ATIS is only available within VHF range of the airport.
- ° The pilot gets a clear printout of the ATIS information. Poor quality of voice transmissions and accent problems are avoided.

4.3.8.3.3. Airports' availability

Digital ATIS is already available for various locations in these countries:

Australia	Denmark	Korea	Singapore
Austria	France	New Zealand	Sweden
Bahrain	Germany	Netherland	Switzerland
Canada	Ivory coast	Norway	Thailand
China	Japan	Portugal	United kingdom
			United States

4.3.8.4. FANS A APPLICATIONS

This part only concerns FANS-equipped aircraft. Further information on the following applications is available in the brochure “Getting to grips with FANS”.

The aim of FANS is to face air traffic growth and increase airspace capacity through the implementation of new communication tools, utilization of accurate navigation equipment and the utilization of new surveillance means. The implementation of new Air Traffic Management methods will result for instance in time and fuel savings.

4.3.8.4.1. AFN

Through this application, an ATC knows whether an aircraft is capable of using FANS datalink communications. The AFN serves to exchange the address information between the aircraft and the ATC center. This exchange of datalink context is **needed prior to any CPDLC or ADS connection**.

4.3.8.4.2. Automatic Dependent Surveillance – Contract (ADS-C)

ADS is a service used by air traffic services in which aircraft automatically provide, **via datalink**, data derived from on board navigation and position fixing systems. Thus, ADS can be seen as a surveillance system. It is “automatic” because position reports and other routine messages are transmitted automatically by equipment on board the aircraft (refer to Appendix A-2).

4.3.8.4.3. CPDLC

CPDLC is a powerful tool to sustain **datalink** communication between a pilot and the controller of the relevant flight region. It is particularly adapted to such areas where voice communications are difficult (HF voice over oceans and remote parts of the world). CPDLC consists in the exchange of preformatted messages such as “Expect climb at [...]”, “Report reaching [...]”

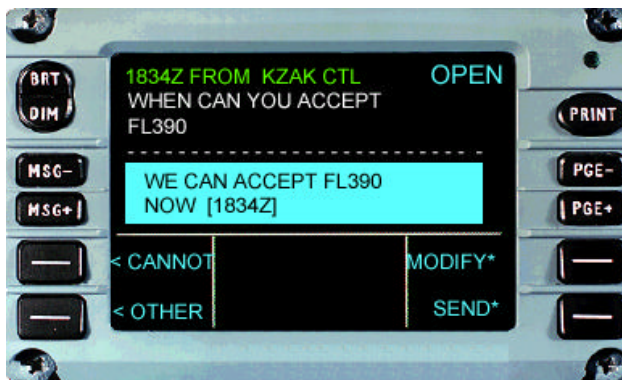


Figure 4.35:
Example of uplink CPDLC messages
(Displayed on the DCDUs)

The main advantages of CPDLC are the followings:

- Reduction of transmission time
- Suppression of the errors or misunderstanding due to poor voice quality and language
- Suppression of mistakenly actions on ATC messages intended to an other flight
- Suppression of the tiring listening watch of the radio traffic
- Immediate access to previously recorded messages
- Automatic load in the FMS of route or FPL clearances

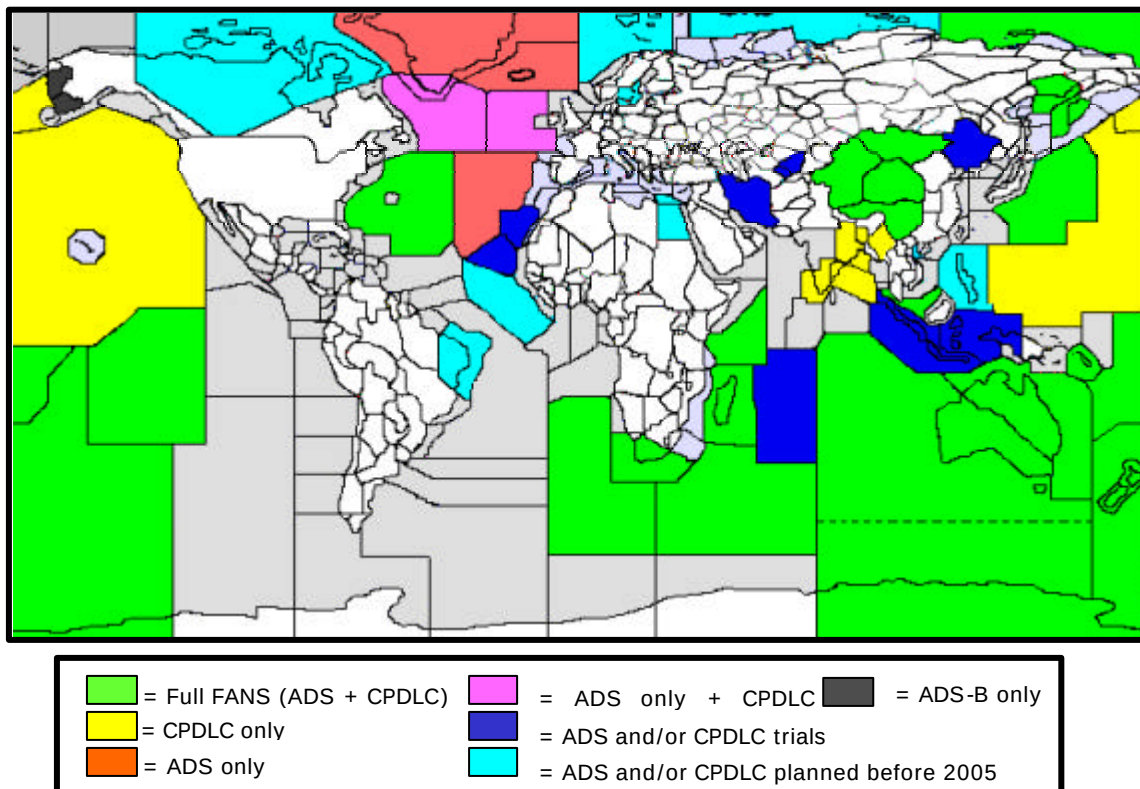


Figure 4.36:
FANS world map

4.3.8.5. FMS WAYPOINT POSITION REPORTING (FMS WPR)

ATSU remote AOC application (FMS)

Some aircraft are equipped with systems that enable non-ADS datalink position reports to be made from the aircraft's Flight Management System. Although designed for aircraft operators' use rather than for ATC purposes, the FMS-WPR, that means the AOC position report, is envisaged by the ATS to enable non-ADS aircraft to report their position through datalink. The use of this FMS WPR is not intended to replace or delay ADS equipage, but is intended to give another solution in the interim.

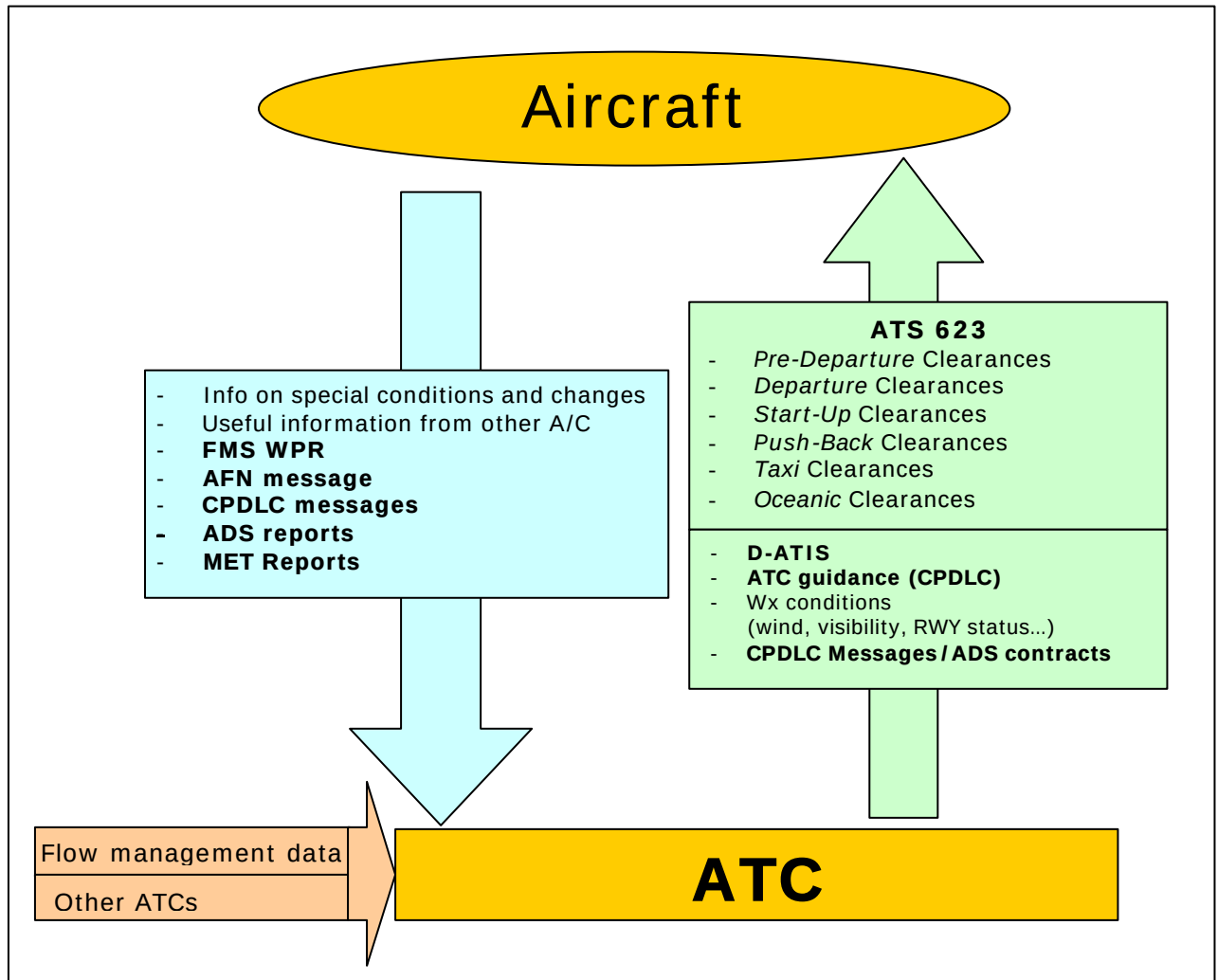


Figure 4.37:
Aircraft / ATC example of exchanged messages

4.4. TYPICAL DATALINK APPLICATIONS PER PHASE OF FLIGHT

Messages	Phase of flight					
	Pre Flight	Flight				Post Flight
		Takeoff & climb	Cruise	Descent & landing	Taxi & parking	
Flight Ops						
ACARS Init REQ	X					
ACARS Init	X					
Preliminary Loadsheet	X					
Notoc	X					
Final loadsheet	X					
Electronic signature	X					
Crew list	X					
Passenger manifest (PIL)						
Take-off data calculation	X					
Landing data calculation			X	X		
Check-in status	X					
Cabin technical status	X		X	X		X
Cleaning status	X					
Catering status	X					
ATC slot - Flow message	X					
FPL / Updated FPL	X		X			
Crew briefing	X					
Flight folder update	X					
ETA report (revision)		X	X	X		
Gate assignment				X	X	
Company Info	X	X	X	X	X	X
De-icing REQ	X					
De-icing	X					
Flight summary						X
Flight Log						X
QAR data						X
Landing pilot report						X
Journey Log						X
FOB report	X	X	X	X	X	X
In-Range report				X		
Approach report				X		
"Out" report		X				
"Off" report		X				
"On" report					X	
"In" report					X	
Position Report			X			
A/C schedule REQ	X					X
Diversion Report			X	X		
Emergency/Mayday report		X	X	X	X	
Hijack/7500 report	X	X	X	X	X	X

Messages	Phase of flight					
	Pre Flight	Flight				Post Flight
		Takeoff & climb	Cruise	Descent & landing	Taxi & parking	
Delays						
Departure delay	X					
Take-off delay		X				
Enroute delay			X			
Holding delay				X		
Gate delay					X	
Maintenance						
MEL Maintenance message	X					
SNAG report	X	X	X	X	X	X
DMU reports		X	X	X	X	X
CMS/CFDS reports		X	X	X	X	
Maintenance Telex	X	X	X	X	X	X
Custimized Reports	X	X	X	X	X	X
Crew						
Crew Re-scheduling				X	X	X
Crew next duty				X	X	
Duty-time alert	X				X	
Updated Crew list	X					
Destination layover data					X	
Cabin technical status	X		X			X
Ground handling companies' information				X		
Cabin Crew reports	X		X	X		X
Cabin Log book						X
Cabin						
Assistance Request (wheel chair, ...)				X	X	
Cabin inventory			X			
On-board sells status			X			
Meals order	X					
List of meals/items uploaded	X					
Non-boarded Pax luggage		X	X			
Credit card authorizations			X			
Pax connecting flight				X	X	
Patient report		X	X	X	X	
Fuel						
Fuel Request*	X			X	X	
Fuel Modification*	X			X	X	
Fuel Confirm*	X			X	X	
Fuel receipt	X					
Reports & free text telex						
OPS RPT	X	X	X	X	X	X
DISPATCH RPT	X					
STATIONS RPT	X	X			X	X
RAMP SVCE RPT	X					X
CREW RPT	X	X	X	X	X	X
MAINT RPT	X	X	X	X	X	X
OTHER RPT	X	X	X	X	X	X

Messages	Phase of flight					
	Pre Flight	Flight				Post Flight
		Takeoff & climb	Cruise	Descent & landing	Taxi & parking	
ATC						
Clearances REQ	X	X	X	X	X	
D-ATIS	X	X	X	X	X	X
PDC/DCL	X					
Startup & Push-back	X					
Oceanic Clearance			X			
AFN		X	X			
ADS		X	X	X		
CPDLC		X	X	X		
AOC FMC WPR			X			
Weather						
SIGMET	X					
TAF/METAR	X					
Climb wind	X	X				
Cruise wind			X			
Descent wind			X	X		
Grid wind	X	X	X	X	X	
Weather map	X		X			
MET reports		X	X	X		
Pax						
Connecting flight info				X	X	X
Airshow		X	X	X		

4.5. ACARS GROUND PROCESSING TOOLS

For some years now, many software have been developed to acquire, read and process these data (refer §2.2). The purpose of this part is to provide Airbus customers with information and point of contact about such tools.

Note: the systems mentioned hereafter do not constitute an exhaustive list; these are just examples.

ADS – Aviation Data Systems

ADS provides a product composed of different modules; each of them enables to complete different actions. The use of these systems altogether enables to get an efficient tool for acquiring and processing ACARS data.

Website: <http://www.avdat.com.au/software/index.html>

Contact: info@avdat.com.au

GDS Honeywell

Honeywell's Global Data Center (GDC) is a source for datalink services, providing flight support services. GDC services include flight planning and filing, vital textual and graphical weather reports and forecasts, essential air traffic services and extensive messaging services.

Website: <http://www.mygdc.com>

Contacts: **Jim Falen**

Business Manager

Phone: (425) 885-8974

james.falen@honeywell.com

James Buckner

Datalink Services Support

Phone: (410) 964-7367

james.buckner@honeywell.com

Hermes - Rockwell-Collins (UK) Ltd

The HERMES Ground Data Link System, developed and produced by Rockwell-Collins (UK) Ltd., is a cost-effective way to meet datalink challenges. Based on modern PC technologies, its n-tier architecture and object-oriented, component-based software design enables a wide range of system solutions, ranging from stand-alone systems to full integration with existing networks and mainframe applications.

Website: <http://www.rockwellcollins.com/about/locations/rcuk/page2127.html>

Contacts: General Enquiries: Email: hermes@rockwellcollins.com

Graham Jones

General Manager

Telephone: +44 (0) 118 935 9325

Email: gnjones@rockwellcollins.com

SITA Fleetwatch

Fleetwatch is a SITA application providing clear graphic representation and easy-to-use sophisticated tools, to plan and manage the schedule. Fleet optimization, weather and program disruption alerting, airport hours and curfew checks, as well as maintenance considerations may all be tailored to provide the airline user with a sophisticated and individualized flight operations system.

Contact: flightops@sitaaero

Website: www.flightops.sitaaero

4.6. COMPARISON OF SERVICE COSTS FOR DATALINK

The following statements are generalities and may defer according to the contract between airlines and DSP.

In general, for ACARS VHF, the airlines pay a monthly subscription charge established on the basis of the number of aircraft using the VHF and VDL service worldwide. These charges are depending on the business relationship and total number of aircraft utilizing the service (thousands of dollars). Besides the fixed charges, airlines also pay per kbits of data. Unlike the VHF network, there is no fixed charge for SATCOM. SATCOM charges are all based on a "pay per transmission" structure.

The cost of a VHF datalink is low as compared to HF (voice communications) and SATCOM; therefore VHF is usually the first choice in the terminal area, airport surface and en-route where coverage exists.

Concerning oceans and remote areas, it is to be noticed that the choice between Satcom and HF DL use is not so obvious. While there is little doubt that an HF DL installation on an aircraft with relatively new HF avionics and antenna tuner can be less expensive than a Satcom installation, the cost differential has reduced considerably as new generation Satcom equipment has come on the market. Furthermore, the Satcom equipment does offer a voice capability for the extra dollars. The cost per kilobit for Satcom and HF DL is set by the service providers, is subject to complicated bulk discounting arrangements and is subject to commercial contractual arrangements between the service provider and the user. There is a perception that Satcom data is expensive, based on historical trends. It is worth noting that some airlines are now using Satcom for ACARS even when in VHF coverage to avoid incurring the high costs associated with using a non-contracted VHF service provider, or to avoid the congestion, which occurs at peak times on VHF. This would appear to indicate that data prices are converging.

There is no general rules concerning datalink cost and case studies must be built with DSPs to find the best contractual arrangement.

Please, bear in mind...

- The **mains actors** involved in the aircraft operation process, aside the crew, are the following:
 - Airline Flight Operations
 - Airline Crew Management
 - Maintenance

Ground handling

- Catering services
- Fuelling services
- Cleaning services
- Passenger assistance
- ATC Centers (Air Traffic Control Centers)

- **Basic Datalink applications**

The firsts applications usually implemented by airlines when starting datalink operations are:

- OOOI (Out-Off-On-In)
- Weather
- Free text telex
- Maintenance

- **Datalink applications per end-users**

Each end-user utilizes a set of dedicated applications.

Flight operations:

Flight preparation files update, Takeoff data, Loadsheet, WPR, FOB, ETA...

Maintenance:

MEL advisory, DMU & CMS/CFDS reports, snag & customized reports...

Crew management:

Delay or Diversion management, pay computation, records and statistics...

Cabin crew:

Pax info, technical reports, catering management, station assistance...

Ground handling:

In-range/approach reports, arrival info, PIL, boarding status...

Passengers:

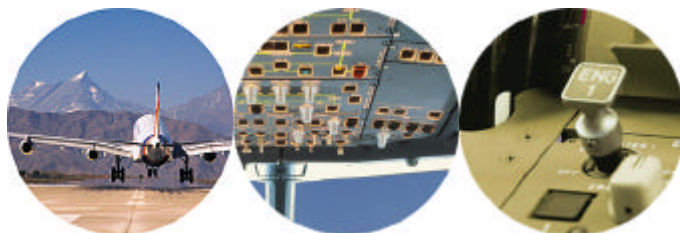
Destination information, connecting flights, re-booking info...

Miscellaneous:

Fueller (fuel request, receipt...), De/Anti-icing (request, location, receipt...)

ATC:

D-ATIS, Clearances (pre-departure/departure, oceanic...), CPDLC/ADS...



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This chapter aims at providing airlines with administrative and technical guidelines so as to ensure proper datalink operations of ATSU-equipped aircraft.

Note: for further information and recommendations to start ATC FANS datalink operations, refer to the “Getting to grips with FANS” document.

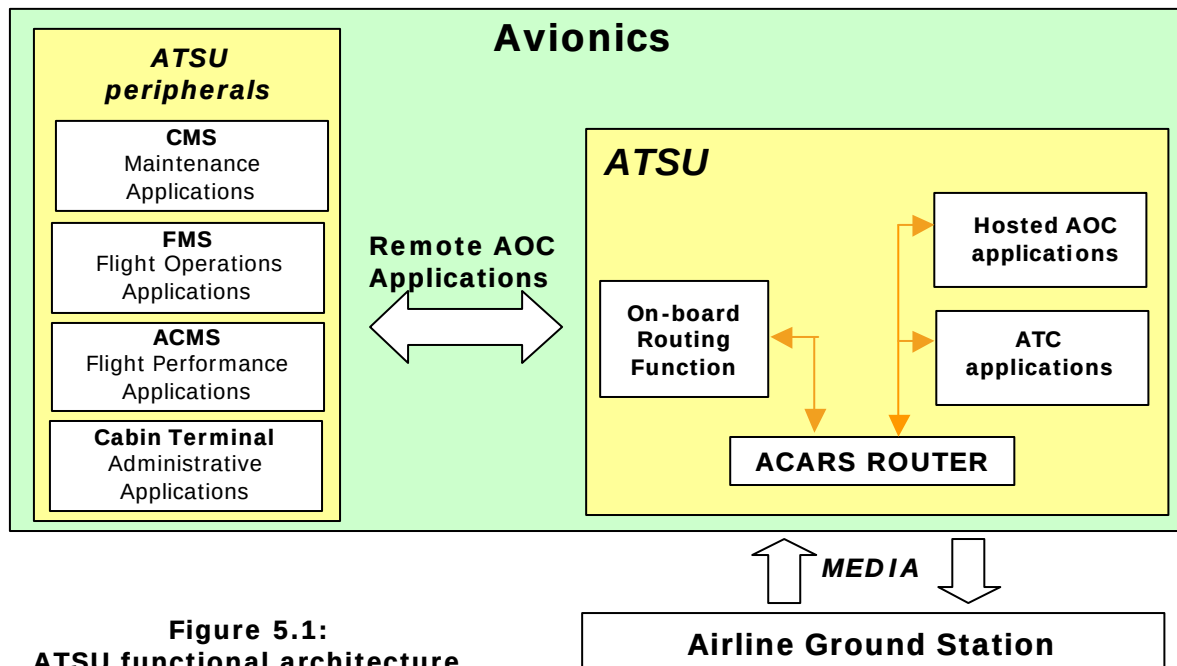
5.1. REMINDER ON THE ATSU ENVIRONMENT

As explained in part 2.4.2, the ACARS router, embedded in the ATSU, routes messages received from the ground to appropriate end-systems onboard the aircraft. These end-systems can be external to the ATSU (FMS, CFDS/CMS, AIDS/ACMS, Cabin Terminals...) or internal to the ATSU (ATC and AOC software partitions).

ATSU-hosted applications are either:

- AOC type applications providing operational functionality, taking into account airline specificity (thanks to high level of customization); or,
- ATS type applications: ATIS, Departure Clearance, Oceanic Clearance, CPDLC/ADS...

Concerning the remote AOC applications, the ATSU acts like an airborne router and does not process data, which are intended to AOC peripherals. Three different operating modes (manual, automatic or following a ground request) are available for messages (or reports) sent to the ATSU (refer §3.2.1).



5.2. CONTRACTS AND CONNECTIONS

5.2.1. DATALINK SERVICE PROVIDER(S) CONTRACTS

5.2.1.1. CONTRACT(S) WITH DSP(S)

To operate datalink, it is necessary to have a contract with at least one of the major service providers (ARINC or SITA) for VDL (VHF datalink) and/or SATCOM datalink and/or HF DL (HF datalink).

If an airline wishes to use more than one service provider, then two solutions may be considered:

- Place contracts directly with each service provider
- Place a contract with a unique service provider who will subcontract data handling to other service providers.

5.2.1.2. AIRCRAFT DECLARATION TO DSP(S)

Once DSPs have been contracted, each individual aircraft must be declared, and identified namely, through its Aircraft Registration Number in Datalink Service Providers tables.

This is an imperative condition to allow datalink message exchanges between an aircraft and the airline host or ATCs on ground.

In addition, the SATCOM AES (Aircraft Earth Station) identification, i.e. the aircraft ICAO address, must be declared to the GES (Ground Earth Station) the aircraft will operate with. This is achieved through registering with Inmarsat using the "Registration for service activation of aircraft AES" form.

The airline should make sure that all service providers to be potentially contacted by a given aircraft have been advised of its datalink capability and identification. Each new datalink-equipped aircraft entry into service must be declared to the service providers selected by the airline and to the ATC centers the aircraft will communicate with.

5.2.2. AIRLINE HOST TERMINAL CONNECTION

An airline network connection, along with a ground processing system, is mandatory to maintain connection with datalink service provider(s) ground network(s).

Further information on the connection and architecture needed is provided by DSPs when contracting themselves.

However, it is to be noticed that there are different types of implementation of airline's ground systems depending on the set of applications that is intended to be used and the assessed implication of each department in the use of ACARS.

A business case concerning the impact of datalink on the entire airline must be built, as impacting all the work organization. The help of external consultants may be required at this step.

Moreover, as an interim solution, it is possible to subcontract the processing/encoding of ACARS messages and have access to a web-based interface. This solution avoids the airline to invest too much in ground processing systems.

Note: Some of the companies listed in §4.5 provides such services.

5.3. DATABASES DEFINITION

The database definitions consist in paper-based forms to be provided to ad-hoc suppliers.

5.3.1. ROUTER PARAMETERS DATABASE

5.3.1.1. STEP 1: AIRLINE CODES AND VHF SCANMASK

The initialization procedure of the ATSU router (airline identification and scan mask) is provided through AMM 46-21-00-860-801 for LR and AMM 46-21-00-860-001 for SA aircraft.

- *IATA and ICAO airline codes*

The IATA two-character and the ICAO three-character airline codes are mandatory to properly initialize the ATSU.

Note: those airline codes must match exactly with those declared to the service provider, as they are essential for messages routing on the ground towards the airline host.

- *VHF scan mask*

The ATSU scan mask is a user-modifiable list of VHF Datalink Service Providers that is used by the ATSU to operate in VHF datalink. DSP(s) to which the aircraft registration number has been declared datalink capable, must be sorted by order of priority in the scan mask. Airlines must therefore set up a scan mask programming policy to be applied on each aircraft. If the scan mask is not set properly, datalink operations will be impacted, and this may result in datalink message losses.

ABBREVIATION	SERVICE PROVIDER	MCDU LABEL	FREQUENCY	Family
SP	SITA PACIFIC	SIT-PAC	131.550 MHz	SITA
SN	SITA NORTH AMERICA	SIT-NAM	136.850 MHz	SITA
SL	SITA LATIN AMERICA	SIT-LAM	131.725 MHz	SITA
SE	SITA EUROPE	SIT-E/A	131.725 MHz	SITA
DE	DEPV BRAZIL	DEPV	131.550 MHz	SITA
AV	AVICOM	AVICOM	131.450 MHz	SITA
AM	ARINC AMERICA	ARI-AM	131.550 MHz	ARINC
AE	ARINC EUROPE	ARI-EUR	136.925 MHz	ARINC
AF	ARINC AFRICA	ARI-AFR	126.900 MHz	ARINC
AK	ARINC KOREA	ARI-KOR	131.725 MHz	ARINC
AS	ARINC ASIA	ARI-ASI	131.450 MHz	ARINC
TLS	AIRBUS TEST TOULOUSE	AIB-TLS	130.600 MHz	EADS
HAM	AIRBUS TEST HAMBOURG	AIB-HAM	122.900 MHz	EADS

Table 5.1:
List of existing Datalink Service Providers

Important notice

Change of ARINC Europe base frequency for VHF datalink

An OIT (provided in Appendix G) has recently been published by Airbus to advise customers that ARINC Europe base frequency for VHF datalink will move from current 136.925 MHz to 131.825 MHz by 30-june-2004. This OIT provided guidelines to ARINC customers to make appropriate ATSU and ACARS settings to support the new frequency.

5.3.1.2. STEP 2: VHF WORLD MAP

From release “CSB2.2” and “CLR4.6”, the ATSU software implements a standard DSP Worldmap based router.

- **Worldmap components**

The DSP Worldmap contains two types of tables:

- a Media configuration tables; and,
- a VHF Worldmap

- **Media configuration tables**

The Media configuration tables give the ARINC 618 parameters for each air/ground communication medium, such as timers, counters, and identifiers. There is a Satcom media configuration table, and a VHF media configuration table for each service provider.

- **VHF World Map**

The DSP Worldmap database contains the VHF geographic areas for each service provider.

In the standard DSP Worldmap, no order of priority is mentioned in case more than one service provider cover an area. The system uses the DSP Worldmap to know which service providers can be proposed for selection in the scan mask. As no order of priority is proposed, in case there are more than one service providers covering an area, a scan mask must be defined in order to define on which frequency it must scan first. This is done through the MCDU SCAN SELECT pages.

As shown hereafter, the Worldmap is described over rectangular zones defined by the latitude/longitude of their south/east limits. The first zone of the Worldmap defined is delimited by 90°N at its North border and 180°W at its West border. The Worldmap can contain up to 512 zones. The order of the service providers is not taken into account.

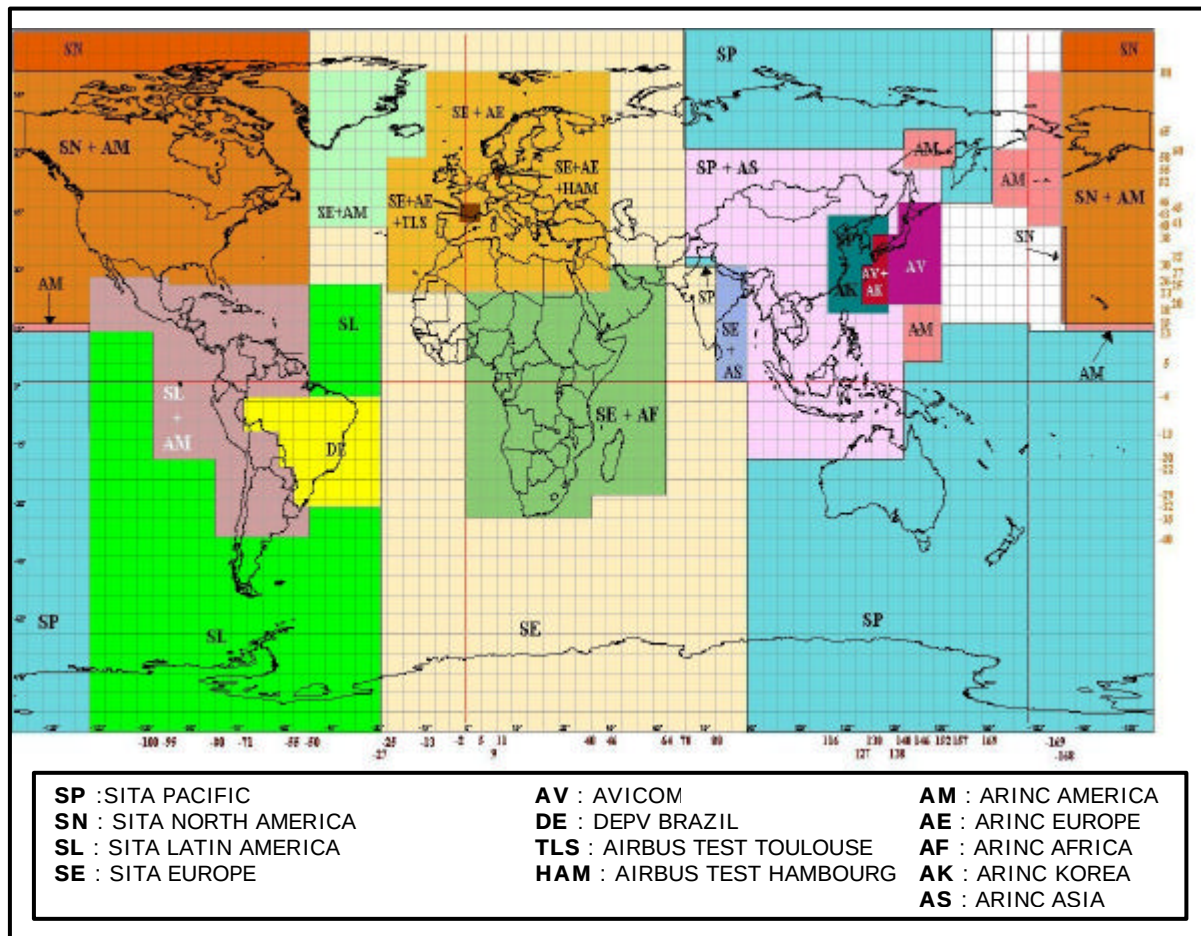


Figure 5.2:
Worldmap graphic representation

- *Example of DSP worldmap: operations in South-America*

In Latin America, ARINC operates on 131.550MHz, and SITA operate on 131.725MHz. Even though there is overlapping of those two service providers in the worldmap, if only ARINC AMERICA is selected in the Scanmask, the ATSU will not communicate over SITA network. If the ATSU cannot communicate with ARINC in VHF, it switches to SATCOM (if installed).

Concerning the above information, ARINC and SITA operate on different frequencies in South America. But, there is a third service provider in the region, DEPV Brazil (Datacom), granting coverage over Brazil on frequency 131.550MHz. Per the ATSU Worldmap, there is no overlapping between Datacom and ARINC coverage; therefore, the ATSU set with ARINC America only in the scanmask will not use VHF Datalink in the region where Datacom coverage is expected.

As explained above, the ATSU scans DSPs only if they are expected to be present according to the aircraft position and the worldmap and if they are selected in the scanmask. In addition, when in dual DSP coverage (according to the worldmap), if both DSPs are selected in the scanmask and if link is established with the lower priority DSP available, the ATSU uses a main/backup algorithm that ensures periodic communication attempts on the highest priority DSP network.

5.3.1.3. ROUTING POLICY DEFINITION

- **For all ATSU software standards**

A routing policy lists a set of allowed media, with a preference order (preference list), and the condition that lead to a change of medium. Depending on the message content, the application is able to choose a pre-defined routing policy.

Thus, the router will try to send the message on the first medium available included in the preference list and for the VHF medium according to the VHF SCAN MASK selection.

The routing policies are customized for Hosted AOC applications

The default ATSU routing policies are the followings:

ATSU Host AOC applications

- **V**: VHF only
- **S**: SATCOM only
- **H**: HF only
- **G**: VHF, then HF, then SATCOM

ATSU Host ATC applications (not user modifiable)

- **V**: VHF only
- **S**: SATCOM only
- **G**: VHF, then SATCOM

- **For ATSU software version CSB2.X & CSB3.X and CLR4.X**

Both the *hosted and remote AOC application routing policies* are configurable by the hosted AOC application for A320 family ATSU software version CSB2 & CSB3, and for A330/A340 CLR4 ATSU software.

5.3.1.4. WORLDMAP, SCANMASK AND ID CUSTOMIZATION

Since April 2004, Airbus has provided an ATSU parameter customization service that will allow airlines to define via database the scanmask and airline Ids (refer to the OIT provided in Appendix H). With the loading of a customized ATSU router database, there is an inhibition of scanmask programming on MCDU, and this will prevent inadvertent scanmask programming. The customization service also allows reducing or removing DSP coverage in a given region.

Remark: for further information, refer to the OIT provided in Appendix.

5.3.2. HFDR DATABASE DEFINITION

The HFDL system table, or HST, is a list of all the HFDL 120-plus frequencies licensed to the HFDL system. This list is modified only several times per year, when frequencies are added to or deleted from the system. The HST is prepared by ARINC HFDL engineers, considering a combination of ionospheric monitoring, polar and geomagnetic data, and HF propagation programs.

When an aircraft logs onto an ARINC HGS, the latter compares the HST version declared by the aircraft to the latest HST version defined by ARINC. If the downlinked version is not up-to-date, the HGS dynamically uplinks the new HST, which is loaded in the HFDR and used for HF frequency management.

5.3.3. SDU DATABASE DEFINITION

The SATCOM user ORT (Owner Requirements Table) embedded in the SDU, is a database in which the airline specifies the GES/satellites on which the aircraft SATCOM system will logon for both voice and data communications. GES are connected to ARINC or SITA networks to provide SATCOM datalink services. Therefore, the programming of the ORT will impact datalink operations if not done properly, i.e. if selected GES are connected to datalink service provider networks to which the aircraft is not declared.

The table 5.2 gives the GES code and associated Satellite code that are used by airborne SATCOM systems to select, according to the priority order set in the ORT, the couple Satellite/GES through which they will operate for both voice communications and datalink.

The ORT cannot be modified via MCDU, thus is less prone to programming errors than the ATSU scan mask.

GES			Satellite		Telecom Operator for voice / fax communications	Service provider for SATCOM datalink
Country	Location	Code (Octal)	Name	Code		
UK	Goonhilly	101	AOR/E	01	British Telecom	ARINC
		001	AOR/W	00		
Norway	Eik	004	AOR/W	00	Norwegian Telecom	ARINC
		104	AOR/E	01		
		301	IOR	03		
Singapore	Sentosa	310	IOR	03	Singapore Telecom	ARINC
		201	POR	02		
Australia	Perth	305	IOR	03	TELSTRA	SITA
		205	POR	02		
France	Aussaguel	103	AOR/E	01	France Telecom	SITA
		005	AOR/W	00		
Italy	Fucino	312	IOR	03	Telecom Italia	NONE
		105	AOR/E	01		
USA	Southbury	002	AOR/W	00	COMSAT	ARINC
USA	Santa Paula	202	POR	02	COMSAT	ARINC
Japan	Yamaguchi	306	IOR	03	KDD	AVICOM
		203	POR	02		
Thailand	Nonthaburi	302	IOR	03	CAT	AEROTHAI

Table 5.2:
SATCOM Operators

5.3.4. AOC DATABASE CUSTOMIZATION

As explained in §3.1, if standard AOC installation (standard software + standard database) is not requested, the airline can install its own customized AOC.

A customized AOC consists in any of the following combinations:

- Customized database + standard software; or,
- Customized database + customized software

It is to be noticed that the AOC software is not required for proper functioning of the ACARS function. Without AOC, the ACARS function still operates for FMS, DMU, CMS/CFDS and Cabin Terminal datalink, subjected to appropriate settings.

Note: if the AIRBUS maintenance ground-processing tool “AIRMAN” is intended to be used, automatic sending of Post Flight Report, Real Time Failure and Real Time Warning must be activated, thus a customized AOC is required. Similarly, Airman requires OOOI messages from the AOC

Customized AOC are not covered by Airbus and cannot be offered to the customer through the RFC process; they can be directly purchased from the AOC vendors.

Note: Only the Airbus Standard AOC is available in Airbus catalogue as an option.

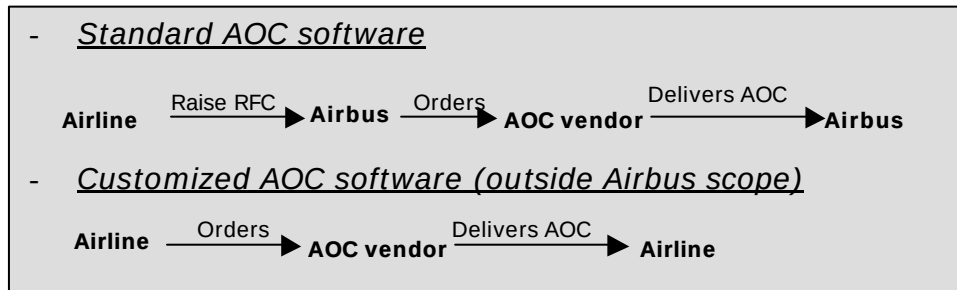


Figure 5.3:
AOC software order & delivery process

5.3.5. CFDS / CMS SETTINGS

Activations of functions in the CMS (LR) / CFDS (SA) allow automatic report transmission to the ATSU. This capability is programmed in the ATSU for permanent settings, through the AOC database (if ATSU hosted AOC application has been loaded), or through the AOC menu on MCDU for temporary settings (refer §5.4.3). The ATSU sends periodically to the CMS / CFDS this information, allowing the CMS / CFDS to know which kind of report has to be downlinked.

Active functions programming concern:

For A320 family:

- Post Flight Report (PFR)
- Real-Time Warning (RTW) & Real-Time Failure (RTF)

For A330/A340:

- Post Flight Report (PFR) *
- Real-Time Warning (RTW) & Real-Time Failure (RTF)
- BITE report

*: On A340-500/-600, the step §5.4.3.2 must also be done to activate PFR

Note: The Servicing report and the Avionics configuration reports can only be manually programmed.

5.3.6. DMU DATABASE CUSTOMIZATION

This paragraph only applies to DMU-equipped aircraft.

The ACARS function / AIDS-ACMS interface provides the capability to transmit to the ground reports for aircraft performance monitoring, engine condition monitoring and APU health monitoring (refer to §4.3.2.2).

Any of the AIDS (SA) / ACMS (LR) Data Management Unit (DMU) can be programmed in order to automatically transfer reports to the ATSU as soon as they are generated or at the end of the flight.

Note: if the ground-processing tool “AIRMAN” is intended to be used, automatic sending of DMU messages must be activated. To obtain an up-to-date AIRMAN prerequisite list, contact airman@transiciel.com.

5.3.7. FMS FILES/DATABASES DEFINITIONS

5.3.7.1. PEGASUS HONEYWELL / THALES (OPC FILE & AMI DB)

- **OPC file:** Within the OPC file, the AOC_Datalink option and the FANS_Datalink option (if FANS-equipped aircraft) must be enabled.

- **AMI database of the FMS**

The FMS database called AMI (Airline Modifiable Information) allows activating the FMS/ATSU interface. A wrong AMI definition can cause FMS-ATSU applications to be inoperative. Airlines are required, by their FMS supplier, to fill-in a form called AMI worksheet, where they must specify the FMS optional functions they wish to use. In order to have datalink functions activated, it is necessary to have the datalink function (Datalink_Inhibits) enabled (§2.5.1 of Honeywell AMI worksheet).

5.3.7.2. LEGACY HONEYWELL (PIN-PROG & APF)

- **Hardware Pin-prog:**

Airlines must raise an RFC to Airbus for hardware pin programming of their FMS. Two functions can be activated:

- *Mini ACARS:* broadcast of FMS data to the ATSU/ACARS
- *Full ACARS:* broadcast of FMS data to the ATSU/ACARS + FMS functions (such as flight plan initialization, reports...)

- **APF (Airline Policy File):**

The interface can be customized in the FMS Airline Policy File, which is included in the navigation database. It must be specified by the Airline to Honeywell (otherwise the interface will not be active)

Note: AMI/APF disks must be physically supplied by the airline for loading after Transfer of Title.

5.4. ATSU INITIALIZATION AND DATABASES LOADING

5.4.1. ATSU ROUTER INITIALIZATION

5.4.1.1. IATA AND ICAO AIRLINE CODES

As mention in part 5.3.1.1, the IATA two-character and the ICAO three-character airline codes are mandatory to properly initialize the ATSU.

The “Flight ID” parameter is automatically created by concatenation of the Airline ID and the numbers of the Flight Number parameter, coming from the FMS (refer to §5.4.1.4 for Flight ID details).

5.4.1.2. ICAO AIRCRAFT ID (FOR VDL2-EQUIPPED AIRCRAFT ONLY)

The ICAO aircraft ID is a 24bit address, which has been originally defined for use with SSR Mode S Transponders for identification of aircraft [ICAO "Aeronautical Telecommunications, Annex 10, Vol. III, chapter 9: Aircraft Addressing System].

ICAO allocates blocks of 24bit SSR Mode S addresses to States of Registry and individual addresses are to be assigned to each suitably equipped aircraft by the State of Registry. Once an airframe has got such an address, it should be fixed and only be changed in case the aircraft changes its State of Registry. No address shall be assigned to more than one aircraft.

Example of 24bit ICAO aircraft Id. of a French aircraft:

State: France Block (binary): 0011 10.. Range in hex 380000 - 3BFFFF

e.g. Aircraft Id. : Binary: 0011 1000 0000 1010 0101 1010
 Hexadecimal: 380A5A

Note 1: This 24bit address is also used as a relevant unique ID element in other interlinked technical communications boxes and protocols on board of aircraft like ATN, TCAS, VDLs.

Note 2: This parameter is automatically obtained from the on-board SSR Mode S transponder; so this data acquisition is fully transparent to the crew.

5.4.1.3. AIRCRAFT REGISTRATION NUMBER

The ATSU receives automatically the ARN from the CFDIU. The ATSU requires the ARN in order to communicate with the ground, because the service providers use it to route messages to the aircraft. The ARN can also be used as a "return address" for the ACARS messages sent from the aircraft.

5.4.1.4. FLIGHT ID. AND THE ACARS ROUTING PARAMETERS

The ACARS system also uses the "Flight ID" parameter, which will be included in all downlink messages; this parameter is created from the A/L ID entered in the MCDU, and the flight number entered in the FMS. The Flight ID contains:

- 2 characters, taken from the 2-characters airline ID parameter: e. g. AP
- 4 digits, taken from the flight number entered in the FMS, justified left.

For instance, if the flight number in the FMS is AIB12345, the digits used will be 1234. Thus the ACARS flight ID is AP1234. If the flight number entered in the FMS is AIB123, the ACARS flight ID will be AP0123.

5.4.2. CUSTOMIZED DATABASES LOADING

The customized AMI or APF, AOC, DMU and ORT databases must be loaded into the FMS, the ATSU, the DMU and the SDU respectively.

Reminder:

- *AMI/APF disks* must be physically supplied by the airline for loading after Transfer of Title.
- *ATSU router initialization* procedure (step1&2) must be supplied to Airbus by the airline in delivery phase.
- *DMU database* must be physically supplied by the airline for loading after Transfer of Title.

5.4.3. CFDS / CMS MANUAL SETTINGS

This part is complementary to the work performed for AOC database definition, as described in §5.3.5.

5.4.3.1. A320 FAMILY CFDS SETTINGS

Among the different data the ACARS/CFDS interface makes possible to downlink (PFR, RTF, RTW and BITE; refer §3.2.3), part of them can be automatically transmitted.

- Post Flight Report (PFR)
This report can be automatically downlinked after second engine shut down (airline selectable) and depending on the “AOC CFDIU PROG” MCDU page.
- Real-Time Warning (RTW) & Real-Time Failure (RTF)
These messages can be transmitted automatically in real-time from the CFDIU to the ACARS function depending on the AOC CFDIU PROG” MCDU page.



Figure 5.4:
AOC CFDIU MCDU page

The here above AOC page of the ATSU allows inhibiting / enabling the transmission of the PFR, the RTW and RTF to the ATSU from the CFDIU.

Note: Any change done through this MCDU page will be reset to the initial value provided by the AOC database at the next ATSU cold start.

5.4.3.2. A330/A340 CMS SETTINGS

Among the different data the ACARS/CMS interface makes possible to downlink (PFR, RTF, RTW, BITE, Class 3 report, Servicing report and Avionics configuration report; refer §3.2.3.), part of them can be automatically transmitted.

- Post Flight Report (PFR)
This report can be automatically downlinked after the last engine shut down and depending on the “REPORTS PROGRAMMING” & “AOC CMC PROG” MCDU page.
- Real-Time Warning (RTW) & Real-Time Failure (RTF)

These messages can be transmitted automatically in real-time from the CMC to the ACARS function depending on the AOC CMC PROG” MCDU page.

- **BITE report**
The downlink is possible after engines shut down and depending on the “AOC CMC PROG” page.
- **Servicing report**
This report can be transmitted automatically 10 minutes after the last engine shut down and depending on the “REPORTS PROGRAMMING” page.
- **Avionics configuration reports**
At each new detected configuration, the Configuration Change Report can be automatically downlinked to the ground and depending on the REPORTS PROGRAMMING” page.

Note: The Servicing report and the avionics configuration reports are part of the CMC option package (refer §3.2.3).

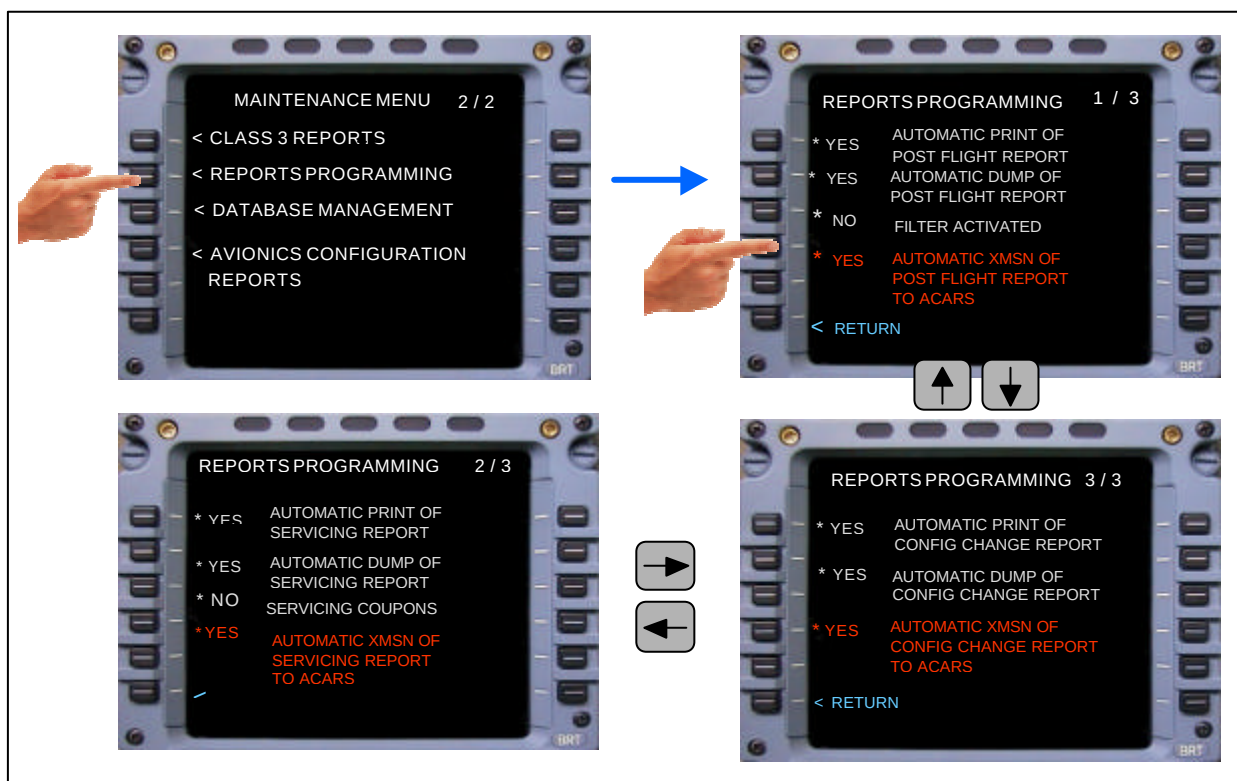


Figure 5.5:
CMS report programming

The automatic PFR transmission activated on the “REPORTS PROGRAMMING” page has to be in addition enabled on the “AOC CMC PROG” page.

BITE report, the ECAM Warning and failure report has to be activated on the **AOC CMC PROG** page only.

Note: it is necessary to ensure that the “Automatic XMSN of PFR” is enabled in REPORT PROGRAMMING page AND in the AOC database (or AOC CMC prog) to get this function.

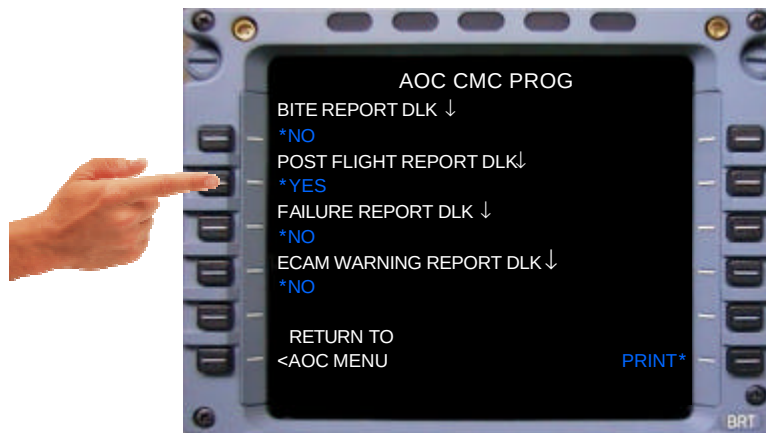


Figure 5.6:
CMS programming

This AOC page of the ATSU allows inhibiting / enabling the transmission of the BITE report, the PFR, the real time warning & failure to the ATSU from the CMC.

Note: Any change done through this MCDU page will be reset to the initial value provided by the AOC database at the next ATSU cold start.

5.4.4. NEW DELIVERED AIRCRAFT DECLARATION TO DSP(S)

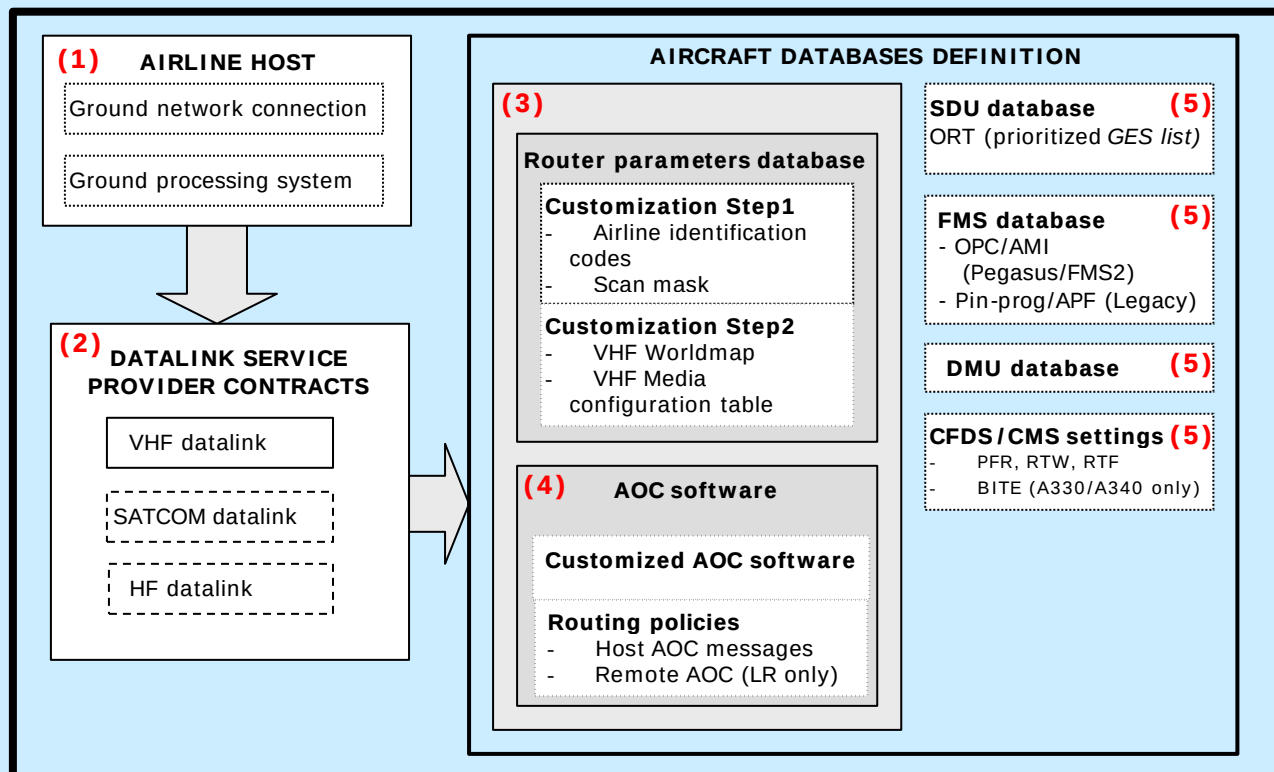
As mentioned in §5.2.1.2, newly delivered aircraft tail number must be declared to the contracted datalink service provider(s) in order to be clearly identified in DSP tables.

5.5. CHECK LIST

Datalink activation / administrative and technical summary

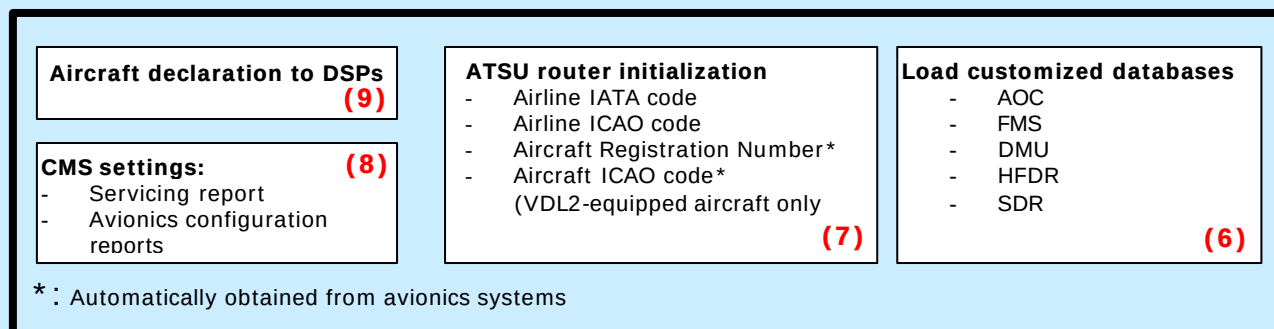
Contracts, Connections and Database definition

Work to be done by the airline for the whole datalink-equipped aircraft fleet



ATSU settings and Databases loading

Work to be repeated for each datalink-equipped aircraft entry into service or datalink retrofitted



Please, bear in mind...

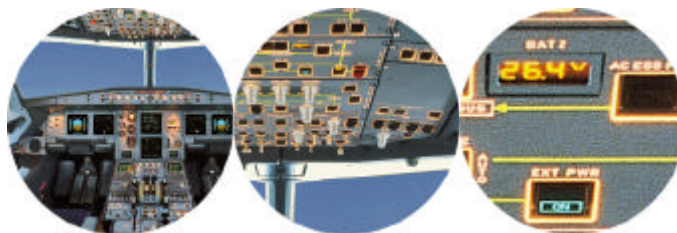
- (1)** – Establish an airline host *terminal connection* to interface DSP ground network with airline ground processing tools.
- (2)** – *Sign contracts* with Datalink Service Provider(s) and *declare* datalink-equipped aircraft.

Databases definition

- (3)** – Define the different router parameters database
 - Step 1: *Airline codes* (IATA and ICAO) along with the *VHF Scanmask* must be set to insure proper routing of messages.
 - Step 2: *VHF World map* should be defined in accordance to airline DSP strategic routing policy.
- (4)** – In case a *customized AOC* is intended to be installed, it must be specified to Honeywell or Rockwell at this step.
- (5)** – Define the Ground Earth Stations/Satellites on which the aircraft will logon in the *SDU Owner Requirements Table (ORT)*.
- (5)** – The *FMS files/databases* have to be defined to activate the FMS datalink capability. This is achieved through:
 - OPC file & AMI Database for Pegasus Honeywell / Thales FMS
 - Pin-prog & APF for Legacy Honeywell
- (5)** – To enable the automatic downlink of DMU reports, the *DMU database* must be programmed accordingly.
- (5)** – The *activation of CFDS / CMS reports* functions is programmed in the ATSU (for permanent settings) and in the AOC database or through the MCDU menu for temporary settings.

ATSU initialization and database loading

- (6)** – The customized AMI or APF, AOC, DMU and ORT databases must be loaded into the FMS, the ATSU, the DMU and the SDU respectively.
- (7)** – The ATSU router initialization step consists in the definition of parameters such as: IATA and ICAO airline codes, ICAO aircraft ID (for VDL2-equipped aircraft only), Aircraft Registration Number.
- (8)** – Complementary settings can be achieved manually on the CFDS / CMS through dedicated MCDU pages.
- (9)** – Newly delivered aircraft tail number must be declared to the contracted datalink service provider(s) in order to be clearly identified in DSP tables.



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6.1. INTRODUCTION: CNS DATALINKS

As mentioned in the previous chapters, the major part of the applications (ATC or AOC) is independent on the datalink used. This means the access to datalink is fully transparent for the application. With the emergence of data communications to provide communication, navigation and surveillance capability along with entertainment services to passengers, requirements have evolved and the choice of communications technology has expanded.

This chapter assesses the datalinks available for aircraft communications and recommends criteria that aircraft operators should take into account in selecting the links to implement in their aircraft.

Moreover, aircraft communications via datalink are being expanded to support functions that were previously classified as navigation and surveillance (such as augmentation of navigation satellites) that increase the impact of communications on aircraft safety.

Guidance on the usefulness of these links is provided to operators in appendix B and C.

6.2. DATALINK FOR COMMUNICATION

6.2.1. VDLS

6.2.1.1. ACARS AND LOW SPEED VHF DATALINK

Low-speed VHF is a character-oriented datalink providing a data rate of up to 2.4 kbps. It was introduced into civil aviation operation in 1978 and is the basic VHF datalink for ACARS. Low-speed VHF is used on a global basis to transmit approximately 35 million VHF messages per month to about 10,000 data link equipped aircraft. This datalink has been used for ATS applications since 1991 in accordance with ARINC specifications 618, 620, 622, and 623. Since the existing low-speed VHF character-oriented datalink is not intended to be part of the Open Systems Interconnection (OSI) Aeronautical Telecommunications Network (ATN), ICAO SARPs have not been developed. Additionally the low-speed characteristic of the datalink requires a number of frequencies to fully service all users. As examples, ARINC uses ten VHF frequencies in the United States to provide reliable service and SITA uses three frequencies in Europe.

Due to its intrinsic limitations and scarce frequency, VHF ACARS should not be able to face for a long time the general growth of the data communications traffic. Therefore, **new VHF datalink systems** have been (or are being) developed and standardized in the AMCP to enable **high-speed VHF communications** over the next few years. The ICAO AMCP, at its first meeting in November 1991, decided to use the name **"VHF Digital Link" (VDL)** for these high-speed VHF data link systems. VDL defines the protocols needed to exchange bit-oriented data across an air/ground VHF data link in an ATN compliant environment.

Different forms of VHF data link have been defined depending on the signal modulation and the network access protocols:

- **Mode 1:** CSMA (Carrier Sense Multiple Access) with MSK-AM modulation at 2.4 kbits/s (similar to ACARS);
- **Mode 2:** CSMA with D8PSK modulation at 31.5 kbits/s;
- **Mode 3:** TDMA with D8PSK modulation at 31.5 kbits/s providing integrated voice and data services;
- **Mode 4:** current candidate technology for ADS-B (refer to Appendix B), VDL Mode 4 is STDMA-based and provides data only services with GFSK or D8PSK modulation but there are patent issues linked to the use of VDL mode 4.

Note: currently only VDL2 is deployed by the Datalink Service Providers. VDL3 deployment is planned over US and VDL4 is still under evaluation processes.

6.2.1.2. VDL MODE 1

While ACARS has not been subject to any ICAO standardization process, VDL Mode 1 has been specifically designed to permit the use of its radio, data modulation scheme and equipment. VDL Mode 1, which enables low-speed bit-oriented data transfer (2 400 bps), is an evolution of the ACARS system as its physical layer conforms with the existing ACARS system (at the same data rate), and layer 2 and 3 with *OSI protocols*. VDL Mode 1 can be seen as a stepping-stone towards VDL Mode 2. However VDL Mode1 was never implemented for operations because VDL Mode2 offered a higher data rate and consequently VDL1 has been recently removed from the ICAO SARPs Annex 10.

6.2.1.3. VDL MODE 2

6.2.1.3.1. Generalities

VDL Mode 2 (VHF Digital mode 2) function provides improved air-ground VHF digital communication link. As the datalink over ACARS continues to increase, the few ACARS channels available in the aeronautical VHF band across busy areas are close to saturation. With a much higher data rate (31.5 Kbps compared to 2.4 Kbps of low-speed VHF), VDL mode 2 was chosen by the industry and the authorities to resolve the problem of the coming ACARS saturation, especially over Europe.

VDL mode 2 was originally designed to be used with an ATN router. As delays have been experienced in the ATN development and deployment on ground, and ACARS is soon to be congested, the VDL mode 2 functions as first been adapted to the ACARS environment. This initial version of VDL2 is called ACARS Over AVLC (AOA). VDL2/AOA is already on the market and deployments are undertaken by the major ACARS service providers (SITA and ARINC) both across Europe and United States (refer § 7.4).

6.2.1.3.2. VDL2 Protocol Characteristics

VDL2 is an air-ground link using 25kHz channels, specified by ICAO AMCP since 1997. Moreover, to improve the effective channel throughput VDL2 uses *digital signal modulation* (operating at a bit rate of 31.5 kbps), along with *error correction* algorithms (Forward Error Correction coding)

To access the VHF channel, the VDL2 protocols implements a p-persistent CSMA (Carrier Sense Multiple Access) algorithm to equitably allow all stations the opportunity to transmit while maximizing system throughput, minimizing transit delays, and minimizing collisions. This is a protocol in which the radio "listens" to the channel to determine if it is idle. If so, the radio transmits with a certain random probability "p" (or stays silent with a probability "1-p"). If the radio does not transmit, it waits a random time before listening again to the channel and repeating the process. The CSMA algorithm offers equitable access to all stations, which means that there is no prioritization of data traffic.

All the messages that are received through VDL mode 2 datalink are managed by the Aviation VHF Link Control (AVLC) sub-layer (refer figure 6.1).

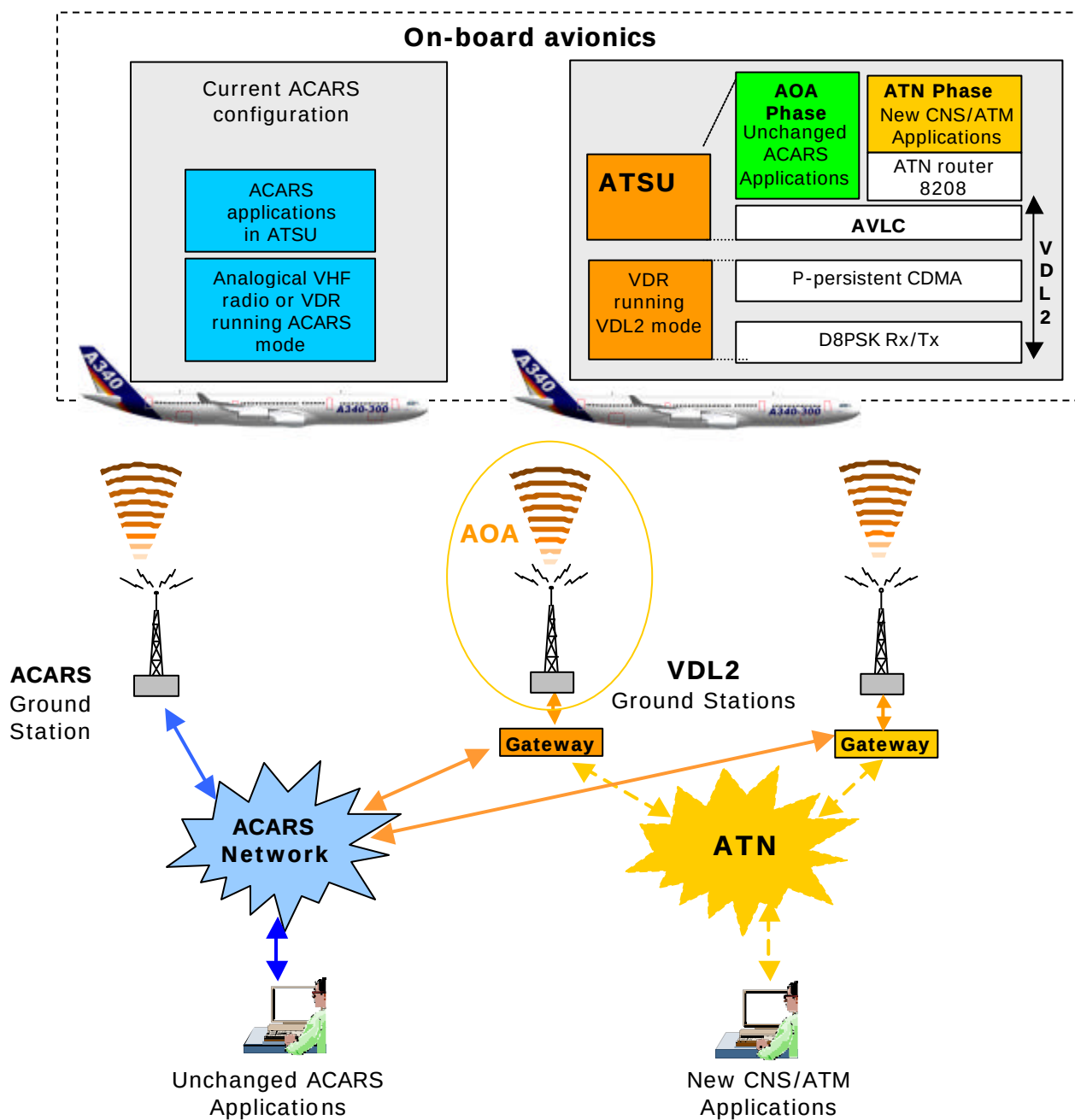
The main functions of the AVLC are:

- Detect and recover transmission errors
- Identify the source and destination of each message
- Organize and manage the data link.

6.2.1.3.3. ACARS Over AVLC (AOA)

The initial version of VDL 2 (AOA) is used by airlines for AOC. VDL 2/AOA aims at delivering a higher message throughput (allowing an 8 to 1 reduction in VHF frequency usage) i.e. the VDL 2 transmission (new aircraft VDRs and VDL 2 ground stations) replaces the low-speed VHF, but other ACARS elements remain unchanged. For VDL 2/AOA to become compliant with ATN, an ISO 8208 layer (ISO equivalent of X.25) must be added on top of the AVLC layer (refer figure 6.1). This "encapsulation" of ACARS packet within AVLC frame allows an easy accommodation (minimizing avionics change) along with a smooth transition to the ICAO CNS/ATM.

The figure 6.1 depicts current ACARS terminals in airlines premises, ACARS network and ACARS implementation onboard. Datalink implemented on ATN/VDL 2 is also depicted



With the initial VDL2/AOA, the VDL 2 air/ground transmission (new radio on board and on ground) replaces the ACARS transmissions but other ACARS elements remain unchanged.

Figure 6.1:
ACARS, VDL2/AOA and VDL2 network

6.2.1.3.4. Standardization

The respective ICAO, RTCA, EUROCAE and AEEC bodies should be contacted or their web pages visited to obtain baseline documentation.

The ICAO SARPs and the 'Technical manual' built by the Aeronautical Mobile Communication Panel (AMCP) can be downloaded from the web site:

<http://www.eurocontrol.int/vdlmode2/library/library.html>. The AEEC specifications related to VDL are ARINC 631 (VHF DL) and ARINC 750 (VDR); part of them are available on this web site.

6.2.1.4. AVIONICS CAPABILITIES

The VDL2/AOA capability is already implemented in existing ATSU, so it requires no change in the airborne architecture. The VDL2 option is available on:

- Single Aisle with ATSU software CSB3.X and Honeywell VDR; Thales avionics and Rockwell-Collins VDR are to be certified by 2004.
- Long Range with software CLR4.X and Honeywell VDR; Thales avionics and Rockwell-Collins VDR are to be certified by 2004.

6.2.1.5. CONCLUSION

The table underneath clearly shows the differences, in term of performances, between VHF ACARS and VDL mode2.

	VHF ACARS	VDL mode 2 AOA
Standards	AEEC	ICAO + AEEC
Bit or Character oriented	Character	Bit
Raw channel data rate	2400 bps	31500 bps
Channel throughput	300-600 bps	10000 - 12000 bps
Network message delivery time	> 5 sec mean	< 3.5 sec (95%)
Service type	Connection-less	Connection-oriented Broadcast capable

As the system is being used today for ACARS communications, there is no technology risk that could undermine benefits. Concerning the signal band, there are no major changes, compared to VDL4 for instance; for these reasons, VDL2/ATN is planned to be the first continental ATC datalink.

Further details on VDL mode 2 are available on the Eurocontrol web page: <http://www.eurocontrol.int/vdlmode2/>

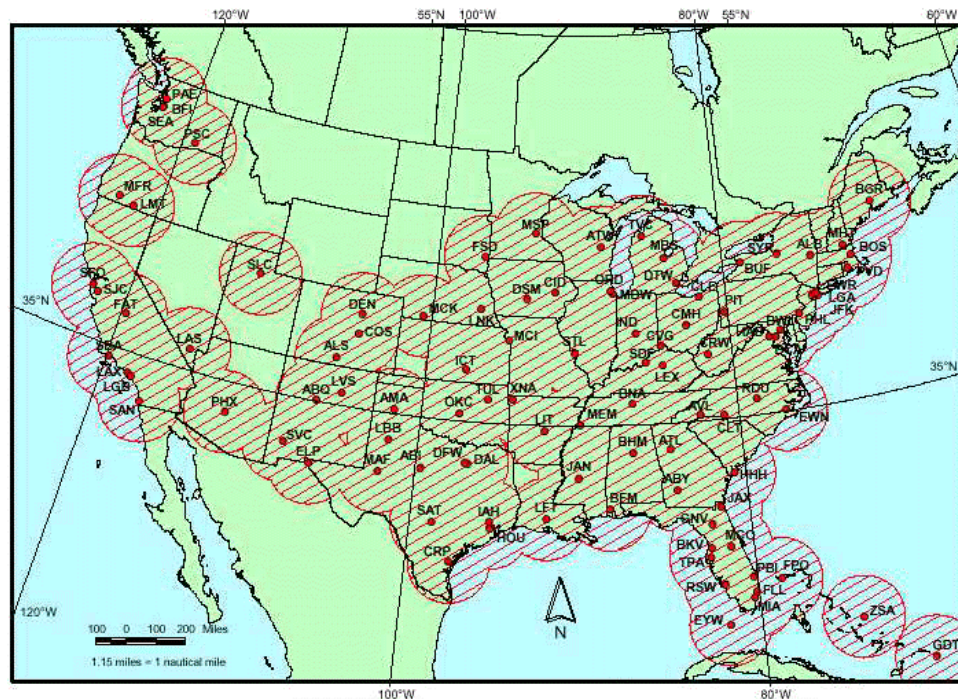


Figure 6.2:
ARINC VDL2 AOA North America available coverage

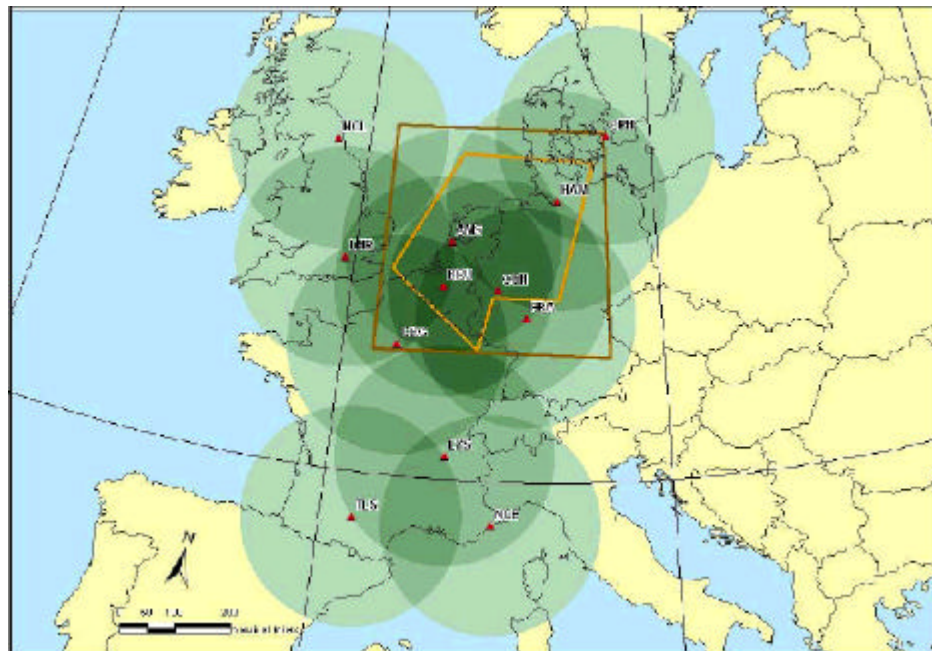


Figure 6.3:
ARINC VDL2 coverage

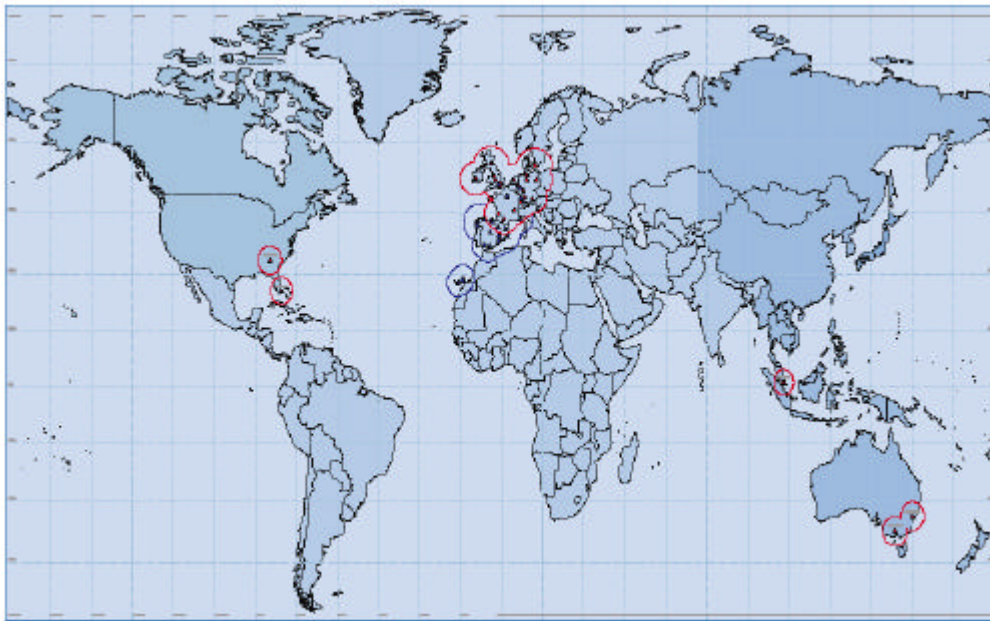


Figure 6.4:
SITA VDL2 coverage

6.2.1.6. PROSPECTIVE VDL MODE 3

6.2.1.6.1. VDL Mode 3 characteristics

VDL Mode 3 is an integrated voice and data link technology based on the TDMA (Time Division Multiple Access) principle. The improved utilization of the VHF spectrum is achieved through the provision of four separate radio channels over one carrier with 25 kHz channel spacing. The maximum data capacity of a VDL mode 3 data channel is 4.8kbps. As shown figure 6.5, there are a variety of configurations (slots assignment) that allows data and voice to be transmitted simultaneously.

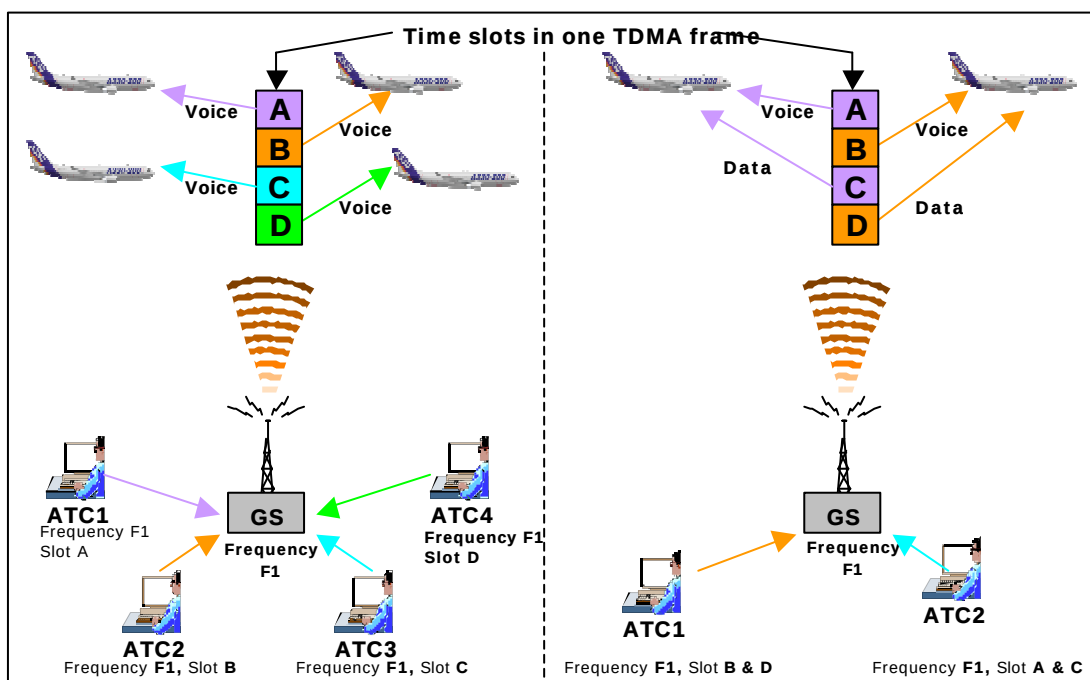


Figure 6.5:
VDL mode 3 configuration

One of the drawbacks of this technology is that the slot assignment is controlled from ground stations and can not be changed dynamically, although the ATC environment is a highly dynamic one, constantly changing due to elements such as weather conditions, airspace traffic, congested communication channels, etc. Moreover, to provide extra capacity in the VHF band where all channels have been assigned, it imposes a complete reorganization, along with the replacement of all the existing analog radios with digital ones. Furthermore, this solution competes to increase voice capacity with 8.33 kHz channels that have already been implemented in many aircraft.

6.2.1.6.2. Status

VDL3 technology is significantly supported in US (FAA), where it is expected to be the next generation technology for both ATS voice and data. AOC data would remain on VDL2. Nonetheless, VDL3 is not supported in Europe where 8.33 KHz voice is being implemented to redress shortage of voice channel. Moreover, if deployed in Europe, VDL3 would require several frequencies.

6.2.2. HF DATA LINK

6.2.2.1. A LONG RANGE COMMUNICATION MEDIUM

6.2.2.1.1. Introduction

Until recently, HF Data Link (HFDL) had not been considered as suitable for aeronautical telecommunications utilization. Over the last few years, trials of prototype systems along with recently collected propagation data indicate that HFDL is capable of providing a suitable level of performance for air/ground data communications. The HFDL service (as defined in AEEC635) allows aircraft that are equipped with capable avionics, to send and receive packet data via a network of HFDL ground stations.

Note: HFDL can be used for AOC purpose since April 2002, and should be certified for ATC communications in 2004 with the FANS A+ package (refer to the “Getting to grips with FANS” brochure).

This chapter shows that the HFDL ground stations network extends air-ground communications coverage beyond the coverage of VHF datalink subnetworks on a worldwide basis and provides an alternate (or backup) to SATCOM on routes over oceans and remote areas. It also indicates that HFDL provides very significant improvements over current HF voice communications in terms of system availability, system capacity, ease of use, and information integrity.

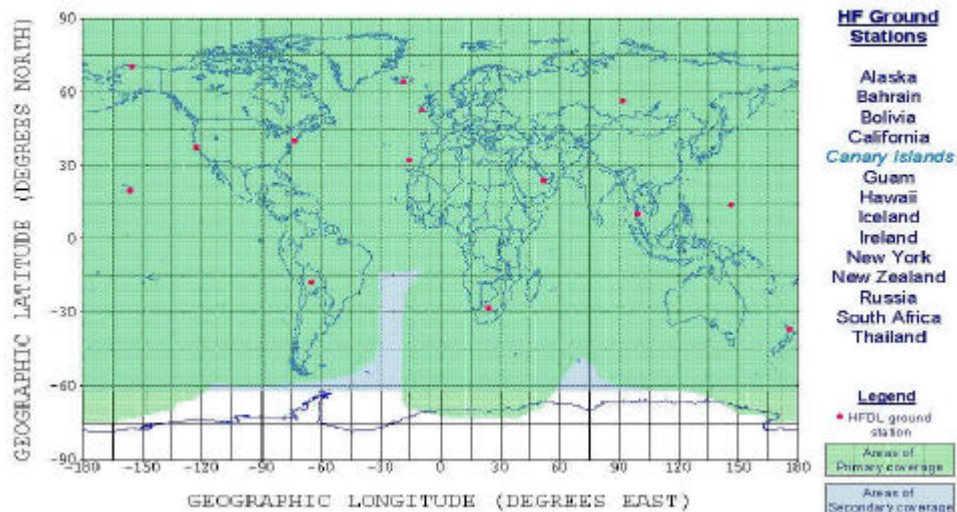
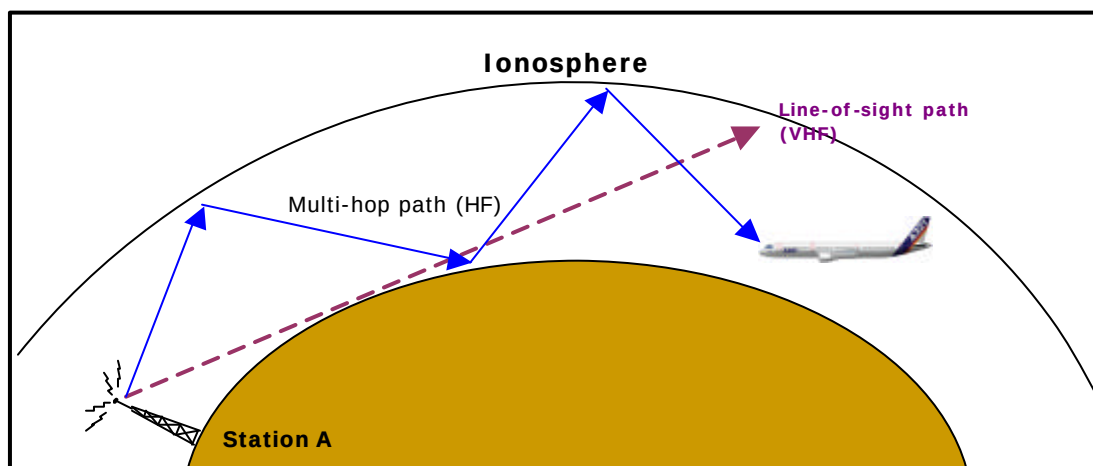


Figure 6.6: GLOBALink / HF global coverage

Note: ARINC is the only Data Service Provider (DSP) providing HFDL service

6.2.2.1.2. HF wave propagation

Many radio frequency bands are influenced by media such as the neutral atmosphere or the ionosphere, and the HF band is no exception. The HF band depends upon the ionosphere for its “skywave” coverage pattern, which enables beyond-line-of-sight (BLOS) communication ranges to 4 000 - 5 000 km and beyond (on multi-hop paths) to be achieved.



The aircraft is able to collect VHF signals coming from station A (because below line-of-sight) but is able to receive HF waves.

Note: many approaches are now available for mitigation of deleterious HF effects and these include advanced signal processing, dynamic frequency management, and a variety of diversity measures to exploit the wide variety of ionospheric effects.

The HF bands of principal interest (2.850 to 22.000 MHz), is not influenced by the wide range of atmospheric phenomena (e.g. severe weather conditions). Nevertheless, it is subject to a number of ionospheric influences which lead to signal distortion and these are dependent upon factors such as ionospheric layer shape and densities, which are functions of geographical and time-vary conditions.

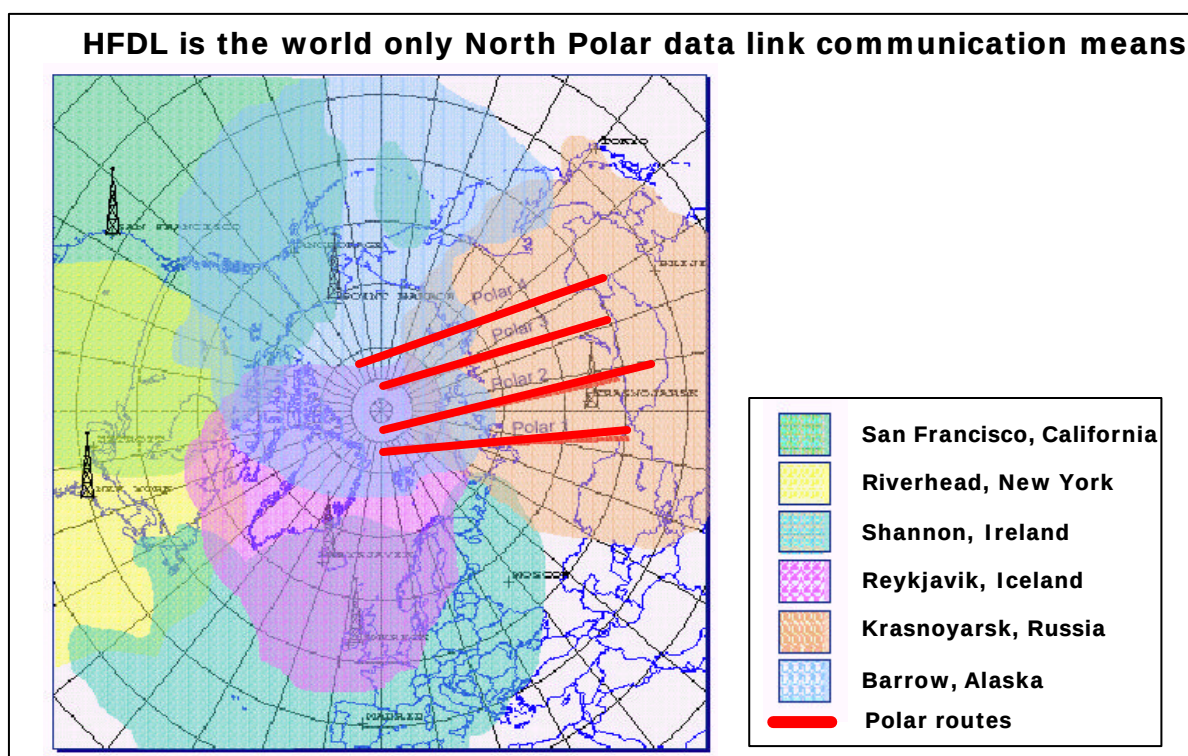


Figure 6.7: HFDL polar coverage

6.2.2.2. HFDL SYSTEM DESCRIPTION

6.2.2.2.1. General architecture

Four separate sub-systems comprise the HFDL system that enables aircraft-based computers to exchange data with ground-based computers:

- HFDL aircraft station sub-system;
- HFDL ground station sub-system;
- HFDL ground communications sub-system; and
- HFDL ground management sub-system.

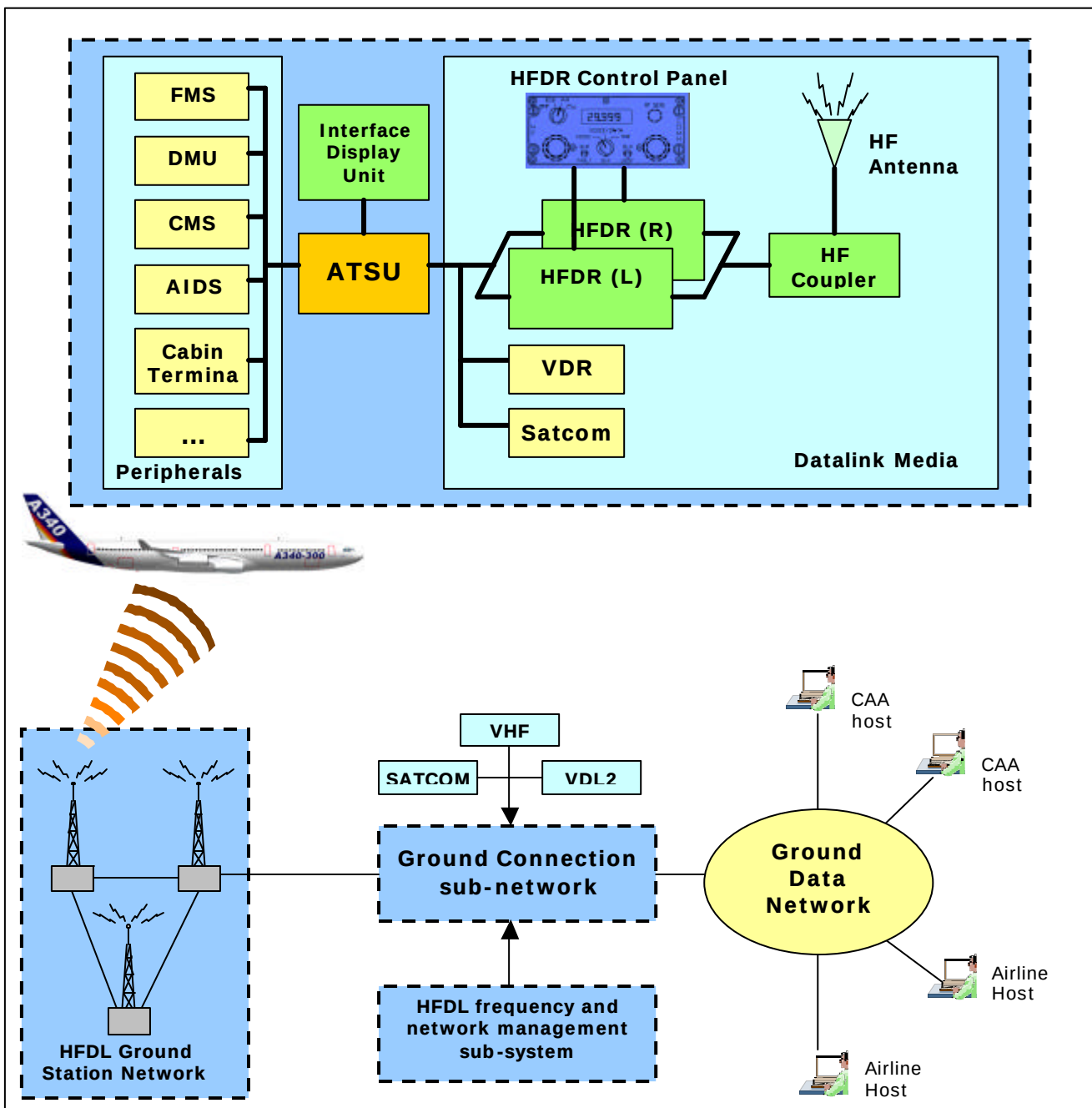


Figure 6.8: HFDL general architecture

6.2.2.2.2. HFDL aircraft sub-system

- *HFDL aircraft sub-system components*

The aircraft station sub-system (figure 6.8) includes the aircraft HFDL equipment and the airborne elements of the HFDL protocol.

- *HFDL capability*

HFDL capability on the aircraft is provided by one of several methods, depending upon the equipment currently installed in the aircraft:

- a) Installing an HF data unit (HFDU) which provides an interface between the ATSU and a conventional HF voice radio; or
- b) Installing a service bulletin upgrade into an existing HF/SSB voice radio which adds HF Data Radio (HFDR) functionality into a single Line Replaceable Unit (LRU) and provides interfaces to the ATSU; or
- c) Installing an HFDR as defined by HFDL SARPs.

6.2.2.2.3. HFDL ground station sub-system

The HFDL ground station sub-system (figure 6.8) includes the ground HFDL equipment and the ground elements of the HFDL protocol. It also provides the interface to the ground-based HFDL end-users.

6.2.2.2.4. HFDL ground communications sub-system

A ground communications infrastructure is required to interconnect HFDL ground stations, end-users, and the HFDL management sub-system. Appropriate Packet Switched Data Networks (PSDN) will provide the connection between ground stations. The communications hubs would operate ATN routers to route messages between HFDL users and the HFDL ground stations, which then relay the messages to the aircraft logged-on the ground station.

6.2.2.2.5. HFDL ground management sub-system

The HFDL ground management sub-system provides the means to operate, manage, and maintain the HFDL system. The HFDL management sub-system provides the following functionality:

- a) Aircraft log-on status table management;
- b) System table management; and
- c) Frequency management.

- *The frequency management function*

The frequency management function is **unique to the HFDL system**. In order to make efficient use of the limited spectrum available for HFDL and to maximize system availability, the HFDL ground stations should share frequency assignments and co-ordinate their use in real-time, based on actual propagation data. HFDL ground stations have a table of frequencies assigned on a geographic basis and associated to operational times. This dynamic frequency management is critical during disturbed propagation that arises as a result of increased solar and geomagnetic activity.

- *Automatic selection of data rates*

HFDL allows for the transmission of data at rates of 300, 600, 1 200, and 1 800 bits/sec. At any time, each link between the aircraft and ground station will have a maximum downlink and uplink data rate.

The maximum uplink rate is determined by the aircraft and provided to the ground station whereas the maximum downlink rate is determined by the ground station and provided to the aircraft. These data rates are determined by evaluating the received signal.

6.2.2.3. HFDL RELATIONSHIP TO OTHER “LONG-HAUL” MEDIA

6.2.2.3.1. HFDL vs. HF Voice

- *Connection sites*

Due to the vagaries of propagation phenomena currently manually tuned, **HF voice** communications is difficult and often unreliable. A great deal of the unreliability is due to the restrictions imposed on voice communications. Most of time, a single HF station handles most voice communications in each FIR. Thus, when a severe ionospheric disturbance affects HF communications within this FIR, all the aircraft in the affected area will experience degraded communications and may have no alternate because they are restricted to making their waypoint position reports to the HF station covering that FIR.

With HFDL, aircraft may communicate with any of a number of inter-networked HF ground stations providing coverage in the same area. Messages are routed to/from the ground end-user via dedicated communication networks. Indeed, the HFDL system is inherently more reliable (higher availability), because ionospheric disturbances are much less likely to affect the communications from a point in the coverage area to all ground stations at the same time.

- *Frequency management*

Current **HF voice** based ATC communications procedures require that aircraft monitor a *primary pre-assigned frequency* to communicate with the responsible ATC center at a given time of the day. A *secondary frequency* is also pre-assigned for use in the event of heavy traffic or poor propagation conditions on the primary frequency. When HF radio conditions degrade, the task of maintaining the voice traffic flow in order to comply with the flight safety regulations becomes increasingly difficult both for the pilot/radio operator in the aircraft and for the radio operators in the ATC communication stations, as message waiting times increase, and the manual frequency selection task grows more difficult.

With HFDL the crew does not have to assume responsibility for finding and tuning to a good frequency and an HF radio operator trying to reach a specific aircraft does not have to hope that the aircraft is monitoring the appropriate frequencies. The HFDL system on the aircraft automatically searches for a suitable (or even the best available) frequency from all HFDL operational ground station frequencies.

Note: The hand-off of the connection from one frequency to another or from one ground station to another is totally transparent to the crew.

- *Spectrum efficiency*

HFDL makes more efficient use of the available HF spectrum than HF voice for a number of reasons.

- Firstly, HFDL employs short burst transmissions in time slots of 2.47 seconds duration to send data packets. A **waypoint position report** can be sent in a single **2.47-second** slot. Furthermore, a time division multiple access (TDMA) and a slot reservation protocol, provides for the assignment of slots, for uplink and downlink transmission, to and from individual aircraft in order to avoid mutual interference between transmissions from ground stations and from multiple aircraft on the same time slot.

Note: A single voice contact to report a waypoint position report typically uses about 1 minute of channel time.

- Secondly, by using digital signal processing techniques to face destructive effects (such as multipath, fading and impulse noise from lightning), more useable spectrum is available with HFDL than with HF voice. Thus, **frequencies that are unsuitable for voice communications have the potential to be used reliably for HFDL.**

	HF Voice Communication	HFDL
Availability of Communications	- < 80%	- > 95% with coverage from 2 HF stations - > 99% with coverage from 3 or 4 HF stations
Spectrum Usage	- 1-2 minutes per position report - Large fraction of available frequency unusable due to multipath and fading	- 2,5 sec. per position report - Digital processing allows use of all available frequencies
Frequency Management	- Operator required to select/find good frequency - Ground can only contact aircraft if aircraft HF radio tuned to good frequency	- Automatic search and selection of good frequency based on channel quality measurement - Automatic hand-off of connection between ground stations
Data/Message Integrity	- Prone to error when operator transcribes voice contact into data message	CRC checksums detect errors Message received with an errors automatically retransmitted

Table 6.9: Comparison of capability of HFDL with HF voice

6.2.2.4. HF DL ATC OPERATIONS

Use of HF DL for an ATC purpose has just been certified on Airbus aircraft (refer OIT “FANS A+”, Appendix H); its operational use now depends on ATC centers authorizations.

6.2.2.5. CONCLUSION

HF DL fulfills several key roles:

- Provides aircraft that are not SATCOM-equipped with a long-range datalink to support ACARS and FANS-A type applications;
- Serves as a datalink for polar regions where SATCOM is not available;

Airline benefits	Flight Crew Summary
An higher reliability reduces ownership costs	GLOBALink/HF is not HF voice
Reduces installation cost Upgrades/renews older HF radios	GLOBALink/HF makes HF work even when HF voice is not available
Preserves airline current HF investment No need for additional external modem Adds data loading to older HF radios	Easier way to give WPR (better use of crew workload)
Reduces pilot workload	FMC position report via HF DL underway
Improves operations as a long-range data link (e.g. ETOPS requirements)	Access to more information outside VHF and even SATCOM coverage
Possibility to use more polar routes (e.g. Europe- Far East) and shorten flight time between far-east and Europe/USA for more than 30 to 45 minutes	

Table 6.10: HF DL benefits

Furthermore, HF DL (even if hindered by very low data rates) is seen as a tool enabling data communication to be extended to new regions and to aircraft previously not able to afford a long-range datalink.

6.2.3. SATCOM: THE AMSS SYSTEM

The Aeronautical Mobile Satellite Service (AMSS) uses Inmarsat geostationary satellites to provide a global communications service to aircraft.

Set up in 1982, Inmarsat was the world's first global mobile satellite communications operator to offer a mature range of modern communications services to maritime, land-mobile, aeronautical and other users. Aircraft have been able to carry out voice and data communications via the Inmarsat satellites since around 1990, when these satellites were expanded from their original function of providing services to ships. Inmarsat aeronautical services offer phone, fax and data services for passenger, administrative and Air Traffic Control (ATC) communications on-board commercial, corporate and general aviation aircraft worldwide. The number of equipped aircraft using the Inmarsat aeronautical service at the end of 2002, was approximately 1,900 air transport aircraft and another 1,700 business jets or government aircraft.

6.2.3.1. CONSTELLATION AND OPERATIONAL COVERAGE

6.2.3.1.1. Inmarsat

The London-based telecom Inmarsat operator is in charge of the satellites constellation implementation, the system maintenance and operations.

From 1997, Inmarsat provides its aeronautical service via four satellites placed in geo-stationary orbit above the equator centered respectively over the Pacific Ocean, Indian Ocean, Atlantic Ocean-East and Atlantic Ocean-West. The Inmarsat satellites provide coverage through a “global beam” between 80 degrees above and below the equator.

Note: a new generation of satellite called “Inmarsat-4” is to be launched in 2005, to provide improved services (refer to §6.2.3.4).

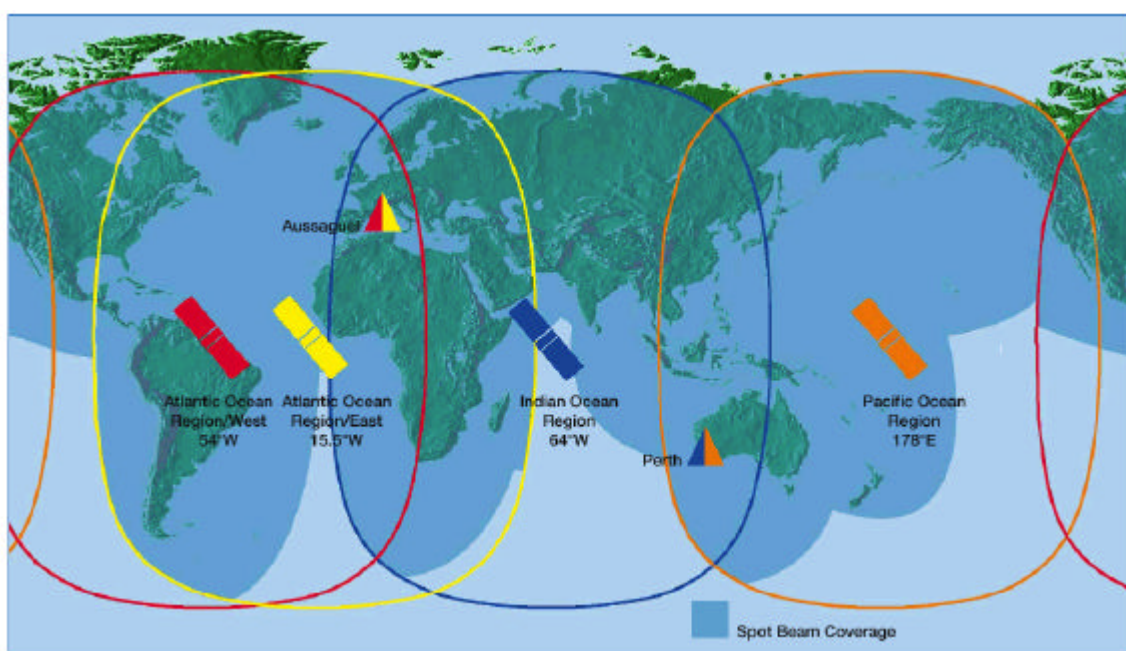


Figure 6.11:
Inmarsat worldwide aeronautical coverage (global and spot beams)

In addition to the four "global beams" described here above, Inmarsat-3 satellites are able to provide local "spot-beams".

Focusing the transmitted power on high traffic areas (representing 95% of major air routes), this enables a more efficient use of the spatial resources, and reduces constraints for avionics (lower cost, lower weight and lower equipment size).

6.2.3.1.2. Prospective systems: MTSAT

Japan Civil Aviation Bureau (JCAB) has decided to implement the ICAO CNS/ATM systems for Japan, centering on Multi-functional Transport SATellite (MTSAT), which will provide the Aeronautical Mobile Satellite Service (AMSS) and Satellite-Based Augmentation System (SBAS) capabilities (refer to Appendix C) for both ATS providers and aircraft operators in the Asia/Pacific Region.

The MTSAT will perform the key role in this new system as aeronautical communication satellite, especially on the north pacific route, which is the main and most expanding air route between Japan and U.S.A. MTSAT will also contribute to improve both safety and capacity in Asia pacific regions

The aeronautical mobile satellite services functions of MTSAT include the provision of all the aeronautical communications defined by ICAO, i.e. air traffic services (ATS), aeronautical operational control (AOC), aeronautical administrative communications (AAC), and aeronautical passenger communications (APC). These communication services could be available for ATS providers and aircraft operators in the Asia/Pacific Regions through datalink service providers. Direct access to MTSAT could also be possible through implementation of dedicated ground earth station (GES) in some states.

Following the system evaluation and staff training for the MTSAT system, the AMSS functions of MTSAT will become operational in year 2005.

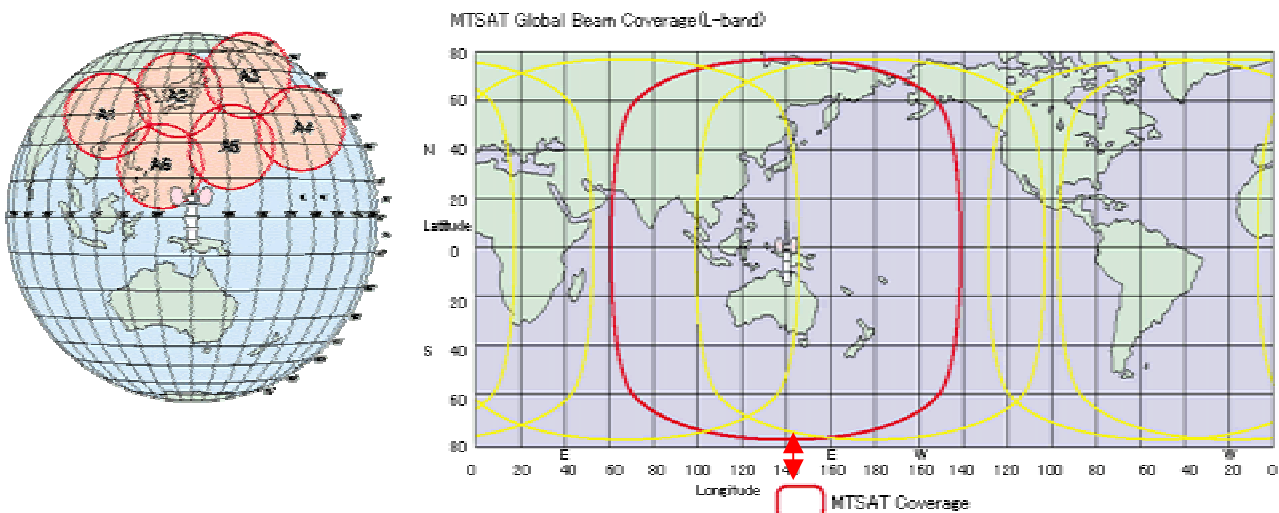


Figure 6.12:
Service areas of MTSAT and Inmarsat

Further information concerning MTSAT is available on the web site:
http://www.mlit.go.jp/koku/04_hoan/e/mtsats/role/01.html

6.2.3.2. SYSTEM ARCHITECTURE

As shown underneath, the AMSS architecture is composed of two main parts: the airborne segment and the ground segment. Each of these components is detailed here below.

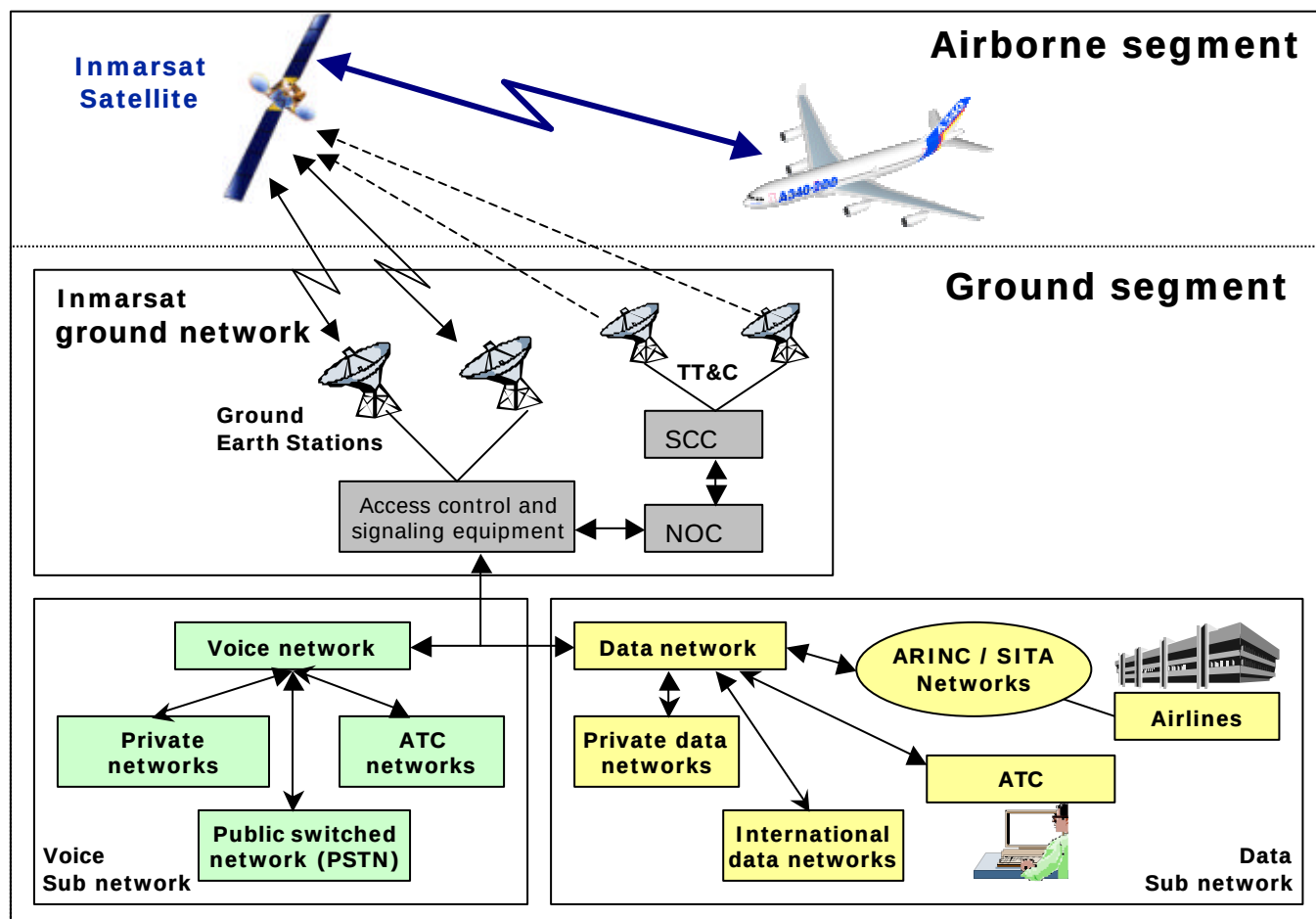


Figure 6.13: Aeronautical system architecture

6.2.3.2.1. Ground segment

The Inmarsat ground network manages the system through the following components:

- The *Satellite Control Center* (SCC) is mainly in charge of in-orbit satellites surveillance, maintenance and station keeping.
- Four "Telemetry, Tracking and Command" Stations (TT&C) (based in Italy, China and 2 in USA) ensure these functions.
- The *Network Operations Center* (NOC) in charge of the dynamic channel assignment to achieve the Quality of service required taking into account the traffic load.

From the GES (Ground Earth Stations) several operational links are provided depending on the communication type (packet or circuit) and the communication service (voice or data).

6.2.3.2. Airborne segment

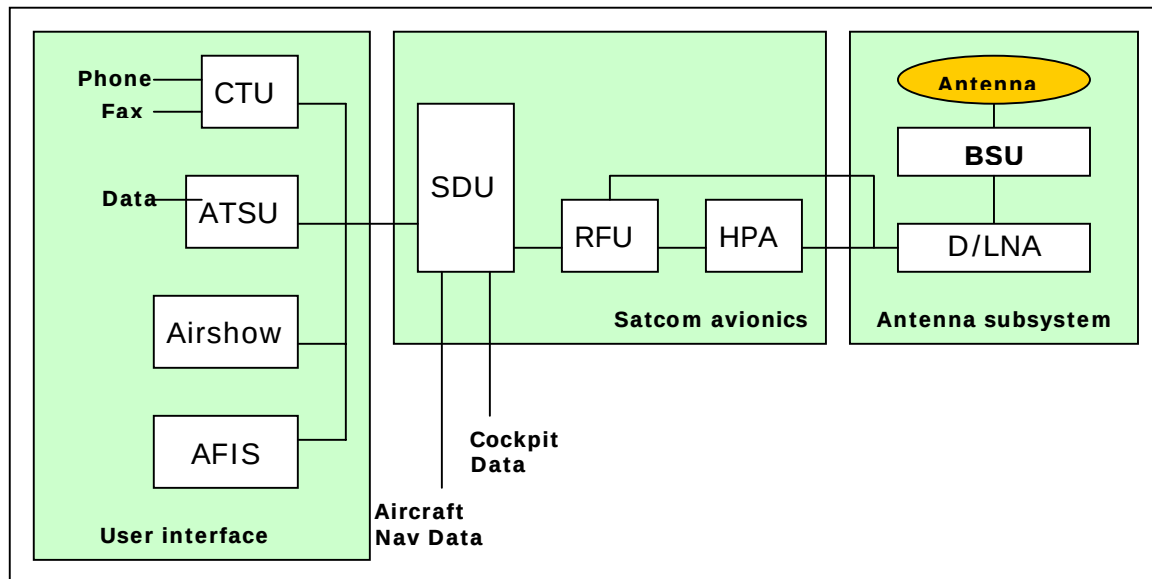


Figure 6.14:
Typical Satcom avionics architecture

The airborne major components are the following:

- SDU (Satellite Data Unit): manages the data exchanges with other avionics equipment
- RFU (Radio Frequency Unit), which is a L-band frequency converter for transmitted and received signals
- HPA (High Power Amplifier)
- LNA/DPLX (Low Noise Amplifier and Duplexer)
- BSU (Beam Steering Unit)
- Antenna (depending from the type of service 0 or 6 or 12 dB)

Note: Depending of the service used (Aero-I/H/H+, refer §6.2.3.4), the aircraft implementations are different

6.2.3.3. AMSS CHANNELS ORGANIZATION

A GES can provide communication with multiple aircraft simultaneously, all sharing access to the available communications channels. A dedicated set of frequencies is made available to aeronautical mobiles and these are broken down by Frequency Division Multiplexing (FDMA) into a number of discrete channels:

- **a single P Channel**, which provides a uni-directional dedicated communications channel from a Ground Earth Station (GES) to all aircraft. Data packets are broadcast over this channel and addressed to a specific aircraft.
- **a single R Channel**, which provides a uni-directional dedicated communications channel from aircraft to a GES. Access to this channel is contention mode using the Slotted Aloha procedure, with the timing signal (for the transmission slots) being provided by the P-Channel.

- **a number of T-Channels**, which each provide a uni-directional dedicated communications channel from aircraft to a GES. T-Channels are used to convey longer messages without the risk of conflict that arises on the R-Channel. T-Channels are allocated by a GES following a request received over the R-Channel
- **a number of C-Channels**, which each provided a bi-directional communications channel between ground and air. C-Channels are typically used for voice communications

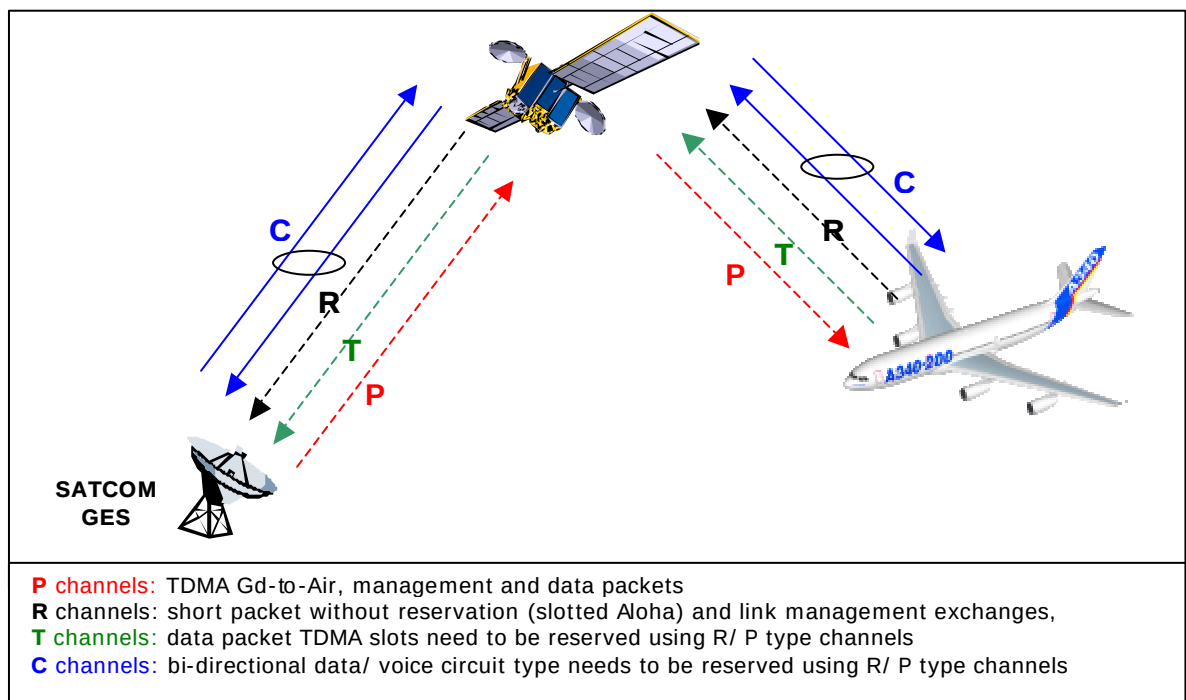


Figure 6.15: AMSS channels organization

6.2.3.4. THE COMMUNICATION SERVICES

Inmarsat aeronautical services for aircraft are supported by three principal systems:

- **Aero I:** This intermediate-gain service was introduced to the Aviation industry in early 2000. Aero I provides customers with multiple voice, fax and pc data connections, equivalent to those offered by the Aero-H+ service. Aero I has spot beam compatible, which means it provides global coverage over mainly high population and air traffic routes.

It is used for communications in narrow-bodied commercial, business and government aircraft. Aero-I uses smaller, less-expensive satellite communications equipment and antennas. Aero-I is designed to meet the regional needs of short- to medium-haul aircraft operators. Aero-I voice, fax and data services operate in the Inmarsat spot beams, while packet data transmissions use global beams. Aero-I is ICAO/SARPS compliant.

- **Aero H:** Best suited for commercial airlines, government and larger business aircraft, Aero-H meets the needs of aircraft operators who require telephony, fax, and data communications for their passengers and crew. This service provides simultaneous, two-way digital voice at 9.6 kbps, fax at 4.8 kbps, and real-time data at speeds up to 10.5 kbps. Aero-H equipment operates in the Inmarsat global beams and is ICAO/SARPS compliant. Aero-H uses high-gain antennas that are available in various designs, including steerable top or side mounted phased arrays and tail mounted mechanical arrays.
- **Aero H+:** The Inmarsat Aero-H+ service is an evolution of the Aero-H service that takes advantage of the Inmarsat-3 spot beams when operating within the spot beam area. When operating outside these areas, the terminal operates using the global beam as a standard Aero-H system. Aero-H+ supports the same services as Aero-H, including CNS/ATM. Aero-HSD + incorporates three Aero-H+ channels: two channels for global voice, fax and PC modem data and one channel for global packet data (cockpit comms).

Note: for further details concerning the terminal migration from Aero-H to Aero-H+, contact your Satcom equipment supplier.

- **Swift64:**

The Inmarsat Swift64 service provides both the high quality and speed of a **full Integrated Services Digital Network (ISDN)** service and the cost-effective flexibility of a **full IP (Internet Protocol) service (MPDS)**. For airline and corporate users, this combination offers unmatched access to modern communications. Swift64 Mobile ISDN offers up to 64 kbps for voice, fax, data communications, etc. ISDN is the preferred option for transmitting larger files, such as compressed video, digital images or graphics. ISDN traffic is charged by the length of time the user remains on-line. Introduced in 2002, it offers data bit rate up to 64 kbps using the Inmarsat III spot beam capability.

Existing Aero-H/H+ customers that are interested in achieving Swift64 service must have their existing system upgraded. Aircraft equipped with Inmarsat avionics including a high gain antenna need only an additional intermediate avionics box to use this new service called “Swift 64”. Aircraft equipped with servers supporting applications such as passenger e-mail and web access can also use this new Swift 64 service to obtain a 64-kbit/sec “ISDN compatible” circuit mode link to ground servers. Initially the Swift64 compatible avionics are being provided by Honeywell or Thales, with other manufacturers expected shortly. Manufacturers already committed to Swift64 avionics include Ball Aerospace, EMS Technologies, Honeywell/Thales, Rockwell Collins, and Thrane & Thrane.

Note: The ICAO Standards and Recommended Practices (SARPs) for aeronautical satellite communications do not define a safety function for Swift64.

- **Inmarsat-4: gateway to broadband**

The new Inmarsat-4 satellites will support the new Broadband Global Area Network (B-GAN), to be introduced in 2006 to deliver Internet and intranet content and solutions, video on demand, videoconferencing, fax, e-mail, phone and LAN access at speeds up to 432kbit/s almost anywhere in the world. B-GAN will also be compatible with third-generation (3G) cellular systems.

Further information concerning the Inmarsat services is available on the web site: <http://www.inmarsat.org/>

6.2.3.5. CONCLUSION

All the applications describe in chapter 4 could be used with Satcom datalink, as they are independent of the media. The aircraft using the AMSS services each month generate a total traffic of approximately 3 million kilobits of ACARS datalink messages (packet mode) and 200.000 minutes of voice calls.

New satellite services offer data rate faster than the link into most homes and comparable in speed with those into many offices. With its ability to share a single channel among a number of simultaneous data users onboard the aircraft, satellite communication offers high effective way of meeting the needs of passengers and crews. Even if these services are still expensive, Satcom is currently the only way to provide broadband datalink all around the world (except polar regions).

6.2.4. GATELINK

6.2.4.1. “GATELINK” CONCEPT

Gatelink has been specified by the aeronautical industry (AEEC 763) to provide **high-speed wireless communications** between an aircraft and a network (or host) on the ground at an **airport terminal** or at a **maintenance position**. This concept of wireless network is a standardized access solution either for fixed, portable or moving aircraft that need to access a Local Area Network (LAN). Rather than being physically connected to the wired network by a cable, the aircraft is connected via a radio link, which gives it the flexibility to move around, while remaining connected to the network.

Currently this technology is only available on A330/A340 and it is to be certified in 2005 on the A320 family.

6.2.4.2. “GATELINK” SYSTEM DESCRIPTION

- *Radio technology choice*

Among the different existing or emerging wireless technologies available today, such as HiperLAN, Bluetooth or IEEE 802.11, the “Gatelink” concept is based on the **IEEE 802.11** wireless LAN standards, which is the most appropriate solution to answer operators’ needs for a wireless access at an airport.

The mains features of IEEE802.11 are the followings:

- IEEE and ISO standard committee approved
- Available data rates from 1Mbps to 11 Mbps
- No need of any license worldwide (as using unlicensed ISM & U-NII bands)

An IEEE 802.11 LAN is based on a cellular architecture, where each cell (called Basic Service Set or BSS) is controlled by a Base Station (called Access Point or AP). Thus, airports are being equipped with APs, which act as bridges between the wireless end-users and the ground Ethernet LAN (IEEE 802.3). Each end-user is connected to the closest AP via a radio connection. This IP-based network remains transparent to customer applications and allows an access to worldwide DSPs’ ground networks. In 1999, the IEEE 802.11 standardized two solutions (referred as IEEE 802.11a and IEEE 802.11b) relevant to Wireless LAN (WLAN) implementation at airports.

The emerging **IEEE 802.11a** Wireless LAN standard, based on Orthogonal Frequency Division Multiplexing (OFDM) enables communications from **6Mbps to 54Mbps** in the 5,8GHz U-NII band for the US.

The **IEEE 802.11b** Wireless LAN standards support Frequency Hopping Spread Spectrum (FHSS) and Direct Sequence Spread Spectrum (DSSS):

- FHSS is standardized for **1Mbps and 2Mbps** connections in the 2,4GHz – 2,4835GHz ISM band.
- DSSS is standardized for **1Mbps to 11Mbps** connections in the 2,4GHz – 2,4835GHz ISM band.

The difference between FHSS, DSSS and OFDM lies in the way the frequency band is used. All three technologies have their advantages and limitations but it should be noted that at the time of writing, the IEEE 802.11b is the most available wireless LAN technology being deployed. Moreover, use of the IEEE 802.11a systems are not possible globally as this frequency band is also used by certain satellite communications systems and part of the spectrum is already allocated to the HiperLAN2 system in Europe.

Remark: The IEEE 802.11 specified Infrared solution, but it will not support a general WLAN airport solution due to its limited coverage ability.

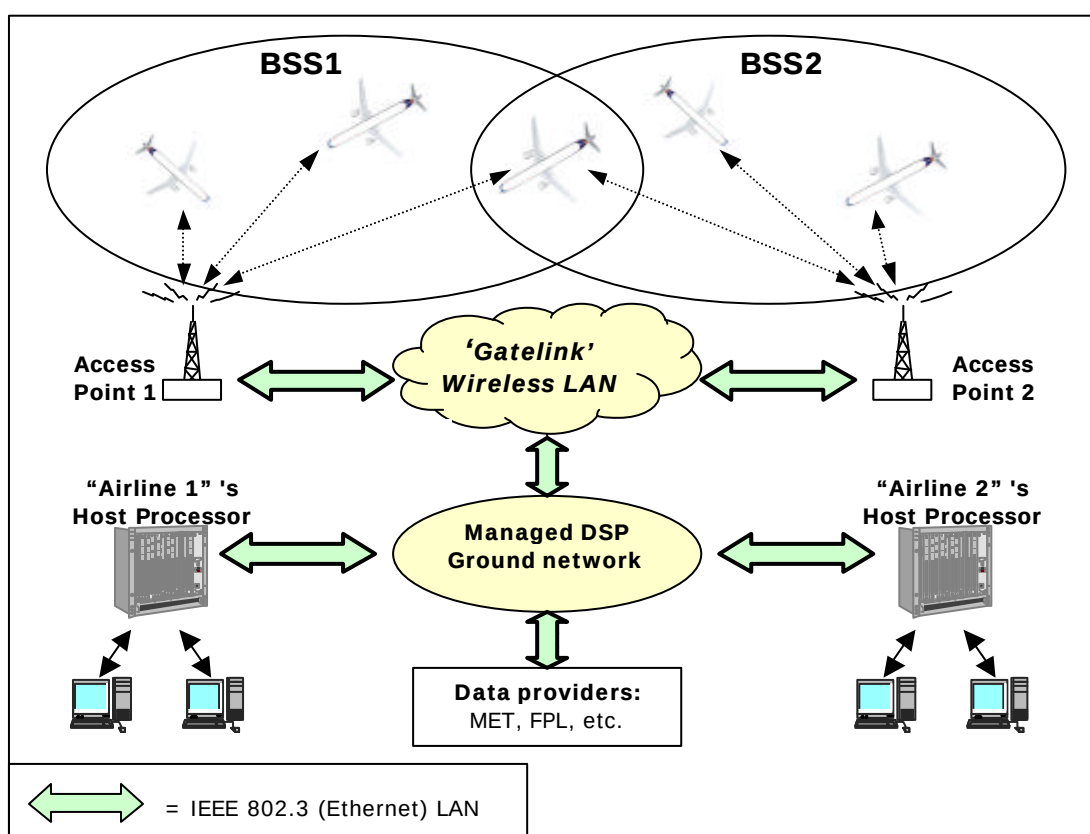


Figure 6.16:
Gatelink end-to-end architecture

- *Protocols: Access to a “Shared” wireless network*

An IEEE 802.11 compliant wireless network is designed to be shared between several users. Therefore, a standardized mechanism has to be followed by all user devices to minimize the risk of data collision. The fundamental network access method of the IEEE 802.11 is “Carrier Sense Multiple Access with Collision Avoidance” (CSMA/CA). CSMA protocols are well known in the industry, where the most popular is the Ethernet, which is a CSMA/CD protocol (CD standing for Collision Detection).

In the CSMA protocols, when a node (a terminal or an interconnection common to two or more branches of a network) receives a packet to be transmitted, it first listens to ensure no other node is transmitting. If the channel is clear, it then transmits the packet. Otherwise, it chooses a random “back off factor” that determines the amount of time the node must wait until it is allowed to transmit its packet. Once this time has elapsed, the node transmits the packet. Since the probability that two nodes will choose the same back off factor is small, collisions between packets are minimized.

Whenever a packet is to be transmitted, the transmitting node first send out a short Ready-To-Send (RTS) packet containing information on the length of the packet. If the receiving node hears the RTS, it responds with a short Clear-To-Send (CTS) packet. After this exchange, the transmitting node sends its packet. When the packet is received successfully, as determined by a Cyclic Redundancy Check (CRC), the receiving node transmits an acknowledgment (ACK) packet. This back-and-forth exchange is necessary to avoid the “hidden node” problem (illustrated in figure 6.17).

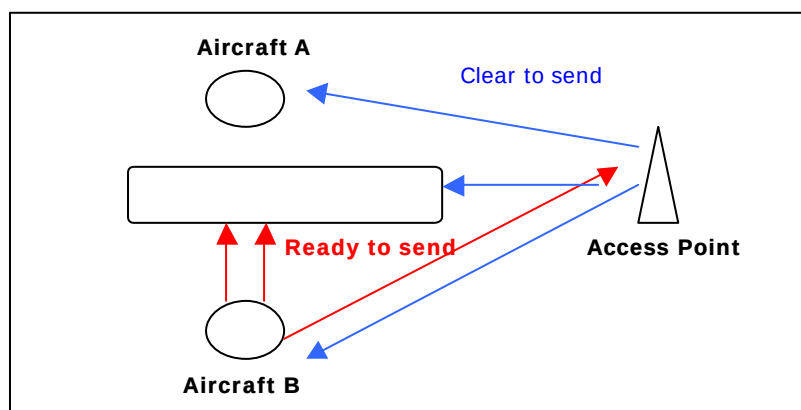


Figure 6.17:
CSMA-CA communication protocol

Aircraft B is hidden from Aircraft A; Aircraft A cannot receive the RTS (Request To Send) sent by Aircraft B. However, Aircraft A is aware that Aircraft B uses the medium thanks to the CTS (Clear To Send) sent by the Access Point.

Remark: It must be highlighted that the Collision Detection, as employed in Ethernet, cannot be used for the radio frequency transmissions of IEEE 802.11. The reason for this is that when a node is transmitting it cannot hear any other node in the system which may be transmitting, since its own signal will drown out any others arriving at the node.

6.2.4.3. ON-BOARD ARCHITECTURE

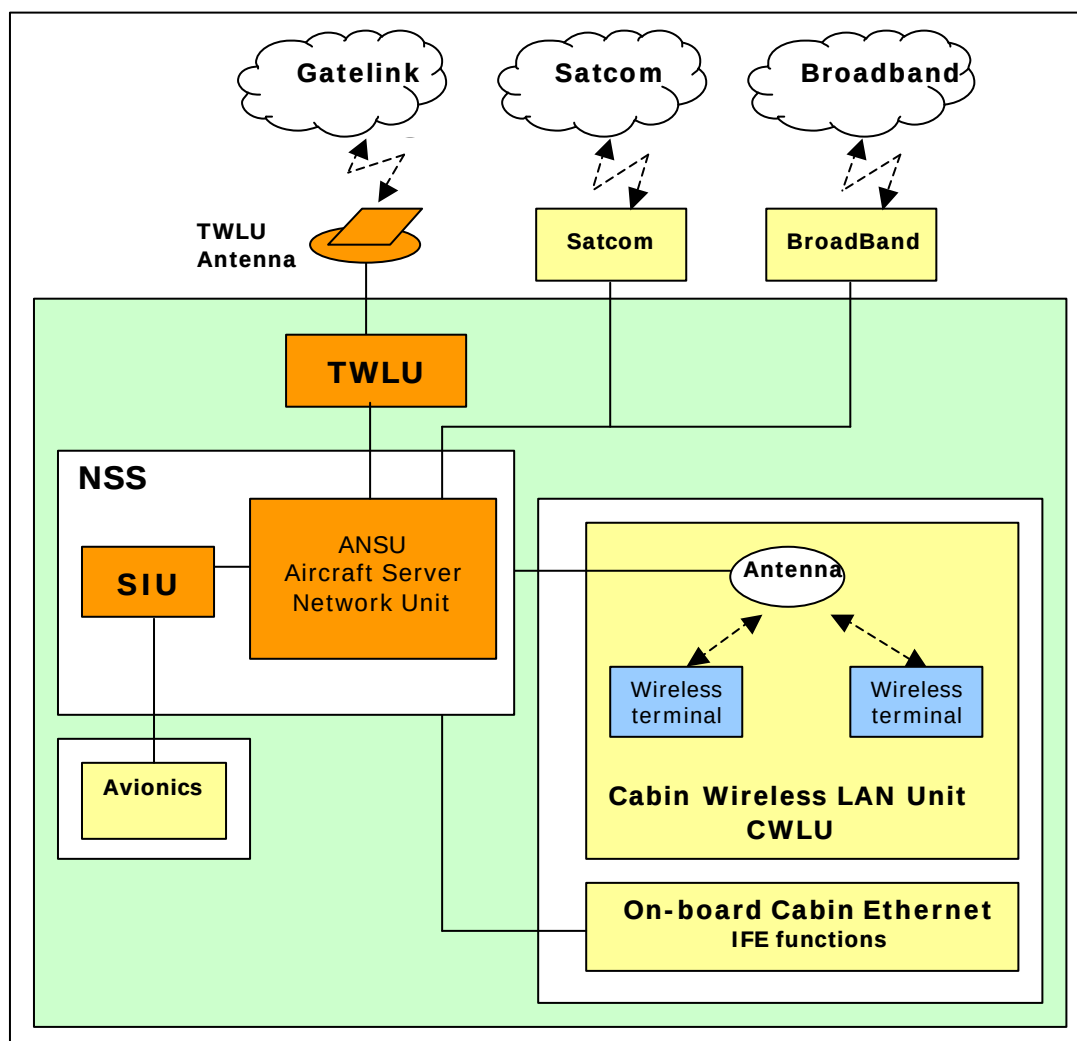


Figure 6.18:
Gatelink on-board architecture

Gatelink on-board equipments consist in:

- A *Terminal Wireless LAN Unit (TWLU)*, with its associated antenna. The TWLU acts as a bridge between the IEEE 802.11 wireless link with the airport access points and the Ethernet onboard network. Thus, it provides connectivity between the aircraft and a ground-based network and allows communication services to the airline and airport networks.
- A *Cabin Wireless LAN Unit (CWL)*, which provides capability to host new passenger wireless services such as e-mail, Intranet, Internet.
- A *Network Server System (NSS)* composed of:
 - . An *Aircraft Network Server Unit (ANSU)*, which provides powerful server and data management functions on-board the aircraft.
 - . A *Server Interface Unit (SIU)*, which provides a security barrier (isolation) between the avionics and open networks.

6.2.4.4. COVERAGE

6.2.4.4.1. Area coverage

The coverage of an access point is the total surrounding physical area in which an aircraft can be connected. Typically, the coverage is **a cell around the access point**, which varies in size and shape. For typical wireless LAN equipment, the maximum distance between an aircraft and an access point is around **300m** when there is no obstacle in between (typically outdoor). The coverage depends on the type and location of the AP, the antenna choice and orientation, and the local environment.

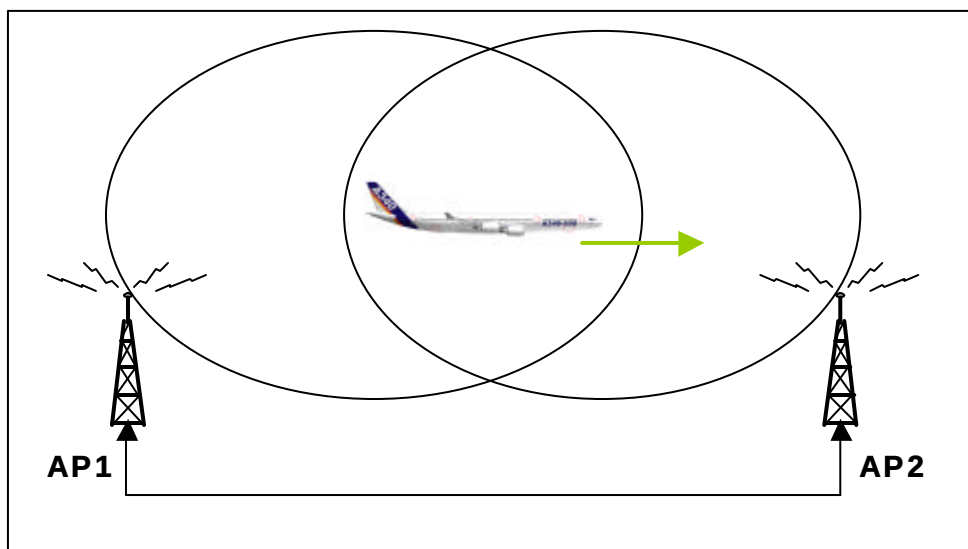
6.2.4.4.2. Roaming and mobility

The wireless network solution allows a user's application to work the same way as if the user were physically connected to the wired network. The **wireless connection is transparent to the user application** to the greatest extent possible. By replacing the wire between the user equipment and the wired LAN by a wireless connection, the user is free to move within the area covered by the access points, maintaining permanent access to the LAN.

For successful worldwide deployment and utilization, the mobility aspect has to be considered at two levels:

- Mobility within an airport (local roaming)
- Mobility between airports (global roaming)

The mobility within an airport is the capability for a user to roam in the same airport from one AP to another, without losing the network connection. Therefore, access points located on the same wired LAN exchange the necessary information to guarantee the roaming transparency for the user application.



AP1 & AP2 exchange data to guarantee transparent roaming

Figure 6.19:
Roaming & mobility

The mobility between airports is the capability for an aircraft or other wireless device to use the same wireless LAN equipment when moving from one airport to the other. Hence, the wireless equipment must adapt to the local regulations of the country. FHSS is the spectrum modulation identified by the Airlines Electronic Engineering Committee (AEEC) for aircraft communications. However, situations could occur where DSSS-based services are the only provided at a given airport. Therefore, some airlines may consider adopting dual-mode FHSS/DSSS on-board equipment, which is an option supported by the AEEC standard.

It is to be noticed that the mix of FHSS and DSSS devices is not possible on the same wireless network due to technological incompatibility. The mode to be used (FHSS or DSSS) on the specific wireless network is controlled by the technology used by the access point. Therefore, interoperability is possible only between devices using the same technology.

6.2.4.5. SECURITY

Security is one of the first concerns of people deploying a Wireless LAN. The main concerns of users are that an intruder would not be able to:

- Access the network resources by using similar Wireless LAN equipment,
- Be able to capture the Wireless LAN traffic (eavesdropping)

Authentication mechanisms and algorithms are part of the IEEE802.11 standards to avoid such intrusions.

6.2.4.6. GATELINK POSSIBLE APPLICATIONS

Applications	Description
Enhanced ATIS	Airport status and local weather
Uplink Loadsheet	Insert flight data for calculation
Crew Management	Crew disposition assignment or composition
Airline Station	Passengers info, Wheelchair, stands, aircrew support, aircraft logistics
Technical Logbook Update	Aircraft Maintenance document and parts catalogue, technical status of the aircraft
Maintenance	Trouble shooting
De Icing request	Info about position in the de- icing queue and status of the aircraft
Dangerous Goods	Info about special and dangerous goods
Handling of Fuelling	Info about Fuel quantity delivered
Flight rotation data	Rotation data of a flight, including arrival and departure times, delays and irregularities
Flight planning	Available flight trajectories
Online aircraft calculation	Transmission of Max take off weight, take off speed, landing weight, engine failure
Aircraft catering	Co- ordination between cabin crews and ground services
Aircraft cleaning	Co- ordination between crew and ground operations
Upload Passenger Entertainment	Updating of Music and Movies on long- range aircraft
Passengers list	Information about passengers on board and their requirements
Baggage handling	Information about the baggage on board and related information

6.3. DATALINK FOR NAVIGATION AND SURVEILLANCE PURPOSES

Datalink is more and more used in the navigation and the surveillance fields.

- In *navigation*, datalink is used to send GNSS corrections to the GNSS receiver in order to increase the position accuracy along with GNSS signals integrity.
- In the *surveillance* field, new concepts (Mode S or ADS-C) or emerging concepts (ADS-B, TIS-B, FIS-B...) are based on the broadcast of aircraft flight information through datalinks, in order to increase the traffic efficiency and the air safety.

All these uses of datalink, along with the associated candidate technologies for each of them, are provided in Appendix B and C.

Please, bear in mind...

- **VHF datalinks (VDL)**

VHF datalinks are the “pipes” most commonly used in civil aviation, because they are economical to implement and they provide excellent operational performance. However, VHF is limited to line-of-sight coverage (nominal range of about 240 NM at 30,000ft).

Low-speed VHF is the basic pipe used for ACARS, but which has also been used for ATS since 1991, in accordance with ARINC (protocol) specifications 618, 620, 622 (bit-oriented) and 623 (character-oriented).

ICAO has not developed SARPs for the low-speed VHF.

VDL mode 2

- VDL2 is an air/ground datalink, nominally operating at 31.5kbps.
- With its much higher data rate (31.5 Kbps as opposed to 2.4 Kbps of low-speed VHF) was chosen by the industry to resolve the problem of ACARS reaching near saturation, especially over Europe.
- The minimal (initial) version of VDL 2 is called ACARS Over AVLC (AOA) and is used by airlines for AOC.
- VDL 2/AOA aims at delivering a higher message throughput (allowing an 8 to 1 reduction in VHF frequency usage) i.e. the VDL 2 transmission (new aircraft VDRs and VDL 2 ground stations) replaces the low-speed VHF, but other ACARS elements remain unchanged.
- ICAO has developed SARPs for VDL 2.

- **High Frequency Datalink (HFDL)**

- HFDL is the only available datalink for polar routes also deployed over remote regions.
- It has a low data rate, is shared among many users, but does support FANS A and ACARS applications.
- It is currently providing complete coverage over the northern polar region, but with a message transit time of about 80 seconds is slower than satellite.
- HF is included in the ICAO SARPs.

- **Aeronautical Mobile Satellite Service (AMSS)**

- AMSS is operated by Inmarsat, providing narrowband services to aircraft
- First operations for AOC in 1990
- It was certified for ATS use in 1992.
- Existing satellite coverage is global, with the exception of Polar Regions, north and south of about 80 degrees of latitude.

- **Gatelink**

- Gatelink has been specified by the aeronautical industry (AEEC 763) to provide **high-speed wireless communications** between an aircraft and a network on the ground at an airport terminal or at a maintenance position.
- This IP-based network remains transparent to customer applications and allows an access to worldwide DSPs' ground networks.
- The typical coverage is a cell around the access point (around 300m).



7. ATN OVERVIEW

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7.1. ATN: THE ICAO RESPONSE TO SUPPORT FUTURE CNS/ATM

In order to overcome compatibility, standardization and other problems, and following the recommendation of the original FANS committee, ICAO has chosen to implement datalink using the ATN technology.

ATN (Aeronautical Telecommunications Network) uses well-defined protocols and equipment, specifically designed to provide a reliable end-to-end communications service over dissimilar networks, in support of ATS. It is intended to provide the means, via a common Internet working protocol, for a worldwide datalink between ground and airborne host computers within the aeronautical community.

ATN is based on *Open Systems Interconnection* (OSI) architecture. The associated SARPs and Guidance Material for ATN were approved in March 1997, and are included in Annex 10. Since datalink applications will be used for directing aircraft movements and/or for providing data to the aircrew so that they can make safe decisions, the integrity of the messages must be sufficiently robust to make the possibility for an erroneous or misaddressed message remote. To meet this requirement the ATN protocols have error-checking functions, at each layer of the OSI.

Compared to ACARS, ATN is a **global standard**, which provides **high data rate**, **high integrity**, more reliable, and robust means for implementing current and future intensive datalink applications.

7.2. THE ATN CONCEPT

The ATN is a data communications internetwork that provides a common communications service for all ATC and AOC applications that require either ground/ground or air-ground data communications services and which meets the security and safety requirements of these applications.

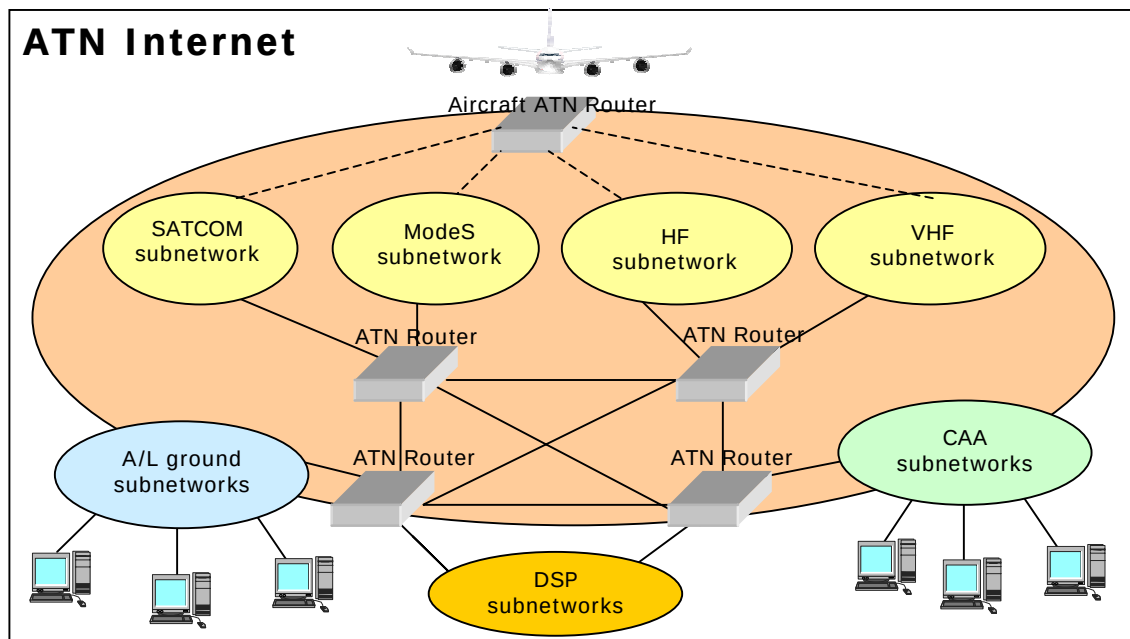


Figure 7.1:
ATN Air/Ground Architecture

The ATN has been specified to meet the requirements of the civil aviation community with the following technical objectives:

- **Use of existing infrastructure:** the ATN integrates existing communications networks and infrastructure wherever possible and uses routers as gateways between those networks.
- **High availability:** the ATN has been designed to provide a high availability network by ensuring that there is no single point of failure, and by permitting the availability of multiple alternative routes to the same destination with dynamic switching between alternatives.
- **Mobile Communications:** the ATN fully supports mobile communications over a wide variety of mobile communications networks including AMSS, VDL, HF DL and Mode S.
- **Prioritized end-to-end resource management:** All ATN user data is given a relative priority on the network in order to ensure that low priority data does not impede the flow of high priority data. Thus, when the network becomes near to saturation, high priority data always gets a low transit delay.

7.3. ATN APPLICATIONS

7.3.1. ATC CNS/ATM APPLICATIONS

The CNS/ATM-1 applications specified for the first phase of ATN deployment have the following purposes:

Air /Ground applications:

- **Context Management (CM)** provides a means to find out about communications services within a given flight region, and for a ground system or controller to direct an aircraft's Context Management Application to contact a different flight region -perhaps as a preliminary to handover.
- **Automatic Dependent Surveillance (ADS)** is designed to give automatic reports from an aircraft to a ground system (refer §4.3.8.5).
- **Controller-Pilot Data Link Communications (CPDLC)**, as described in part 4.3.8.5.
- **Flight Information Services (FIS)** can support a variety of information services, providing information about the ground to an aircraft. This can include information about an airport, such as "runways in use" and weather conditions.

Ground /Ground applications:

- **ATS Interfacility Data Communication (AIDC)** provides for the exchange of ATC information between Air Traffic Control Centers in support of ATC functions, including notifications of flights approaching a Flight Information Region boundary, co-ordination of boundary crossing conditions, and transfer of control.
Note: this is not an ATN specific function, has already implemented in some ATC centers.
- **The Aeronautical Message Handling System (AHMS)** provides for the exchange and distribution of message-oriented traffic between Air Traffic Control Centers. It is an AFTN replacement that may be used additionally to provide new messaging services including Electronic Mail and Electronic Data Interchange.

7.3.2. AOC APPLICATIONS

All the AOC applications defined in chapter 4 are “ATN compatible” and, many enhancements could be envisaged due to an increased security and greater data rates. It is intended to migrate AOC applications on ATN to have one global network instead of several particular subnetworks.

7.3.3. ATN GROUND NETWORK

The ATN Internet (refer figure 7.1) is made up the following functional components:

- **End Systems (ESs):** provide the end-user applications with an OSI compliant communications interface to enable them to communicate with remote end-user applications.
- **Intermediate Systems (ISs):** these routers relay data between different ATN subnetworks (air-ground or ground-ground), such that ATN End Systems may exchange data even when they are not directly attached to the same subnetwork.
- **Ground-Ground communication subnetworks**
- **Air-Ground communication subnetworks**

7.3.4. ATN AIRCRAFT ARCHITECTURE

The data communications equipment on board an aircraft also includes a router that links the communications equipment specific to each air/ground datalink to an internal avionics LAN, to which avionics equipment with datalink capability is attached.

The transition to a full-ATN implementation will follow several steps. At the beginning, ATN will be introduced only for ATC communications; through the use of a so-called “ATN-stack”, to process ATN ATC messages. Non-ATN aircraft are still going to be able to receive messages from ATN ATC through the AOA protocol, which will allow a smooth transition. Then, ATN AOC will be introduced. During this transition from non-ATN to full-ATN aircraft, a “double-stack” (ACARS/ATN) will be necessary to handle both ATN and ACARS messages.

7.3.5. ATN AIR-GROUND COMPONENTS

A major ATN requirement is to support ICAO Mobile Data Networks and the systems (typically aircraft) that use them. The sub-networks that are expected to be used in the early ATN are the followings (defined in chapter 6):

- The VHF Datalink (VDLs) sub-networks
- The Mode S Datalink sub-network
- The Aeronautical Mobile Satellite Service (AMSS)
- The HFDL sub-network

Other sub-networks such as Gatelink, Low Earth Orbit (LEO) satellites constellations could then be connected to the ATN Internet.

Further information on these subnetworks is provided in chapter 6.

This figure shows the shared AOC and ATC network during the transition step from the non-ATN world to the full-ATN world.

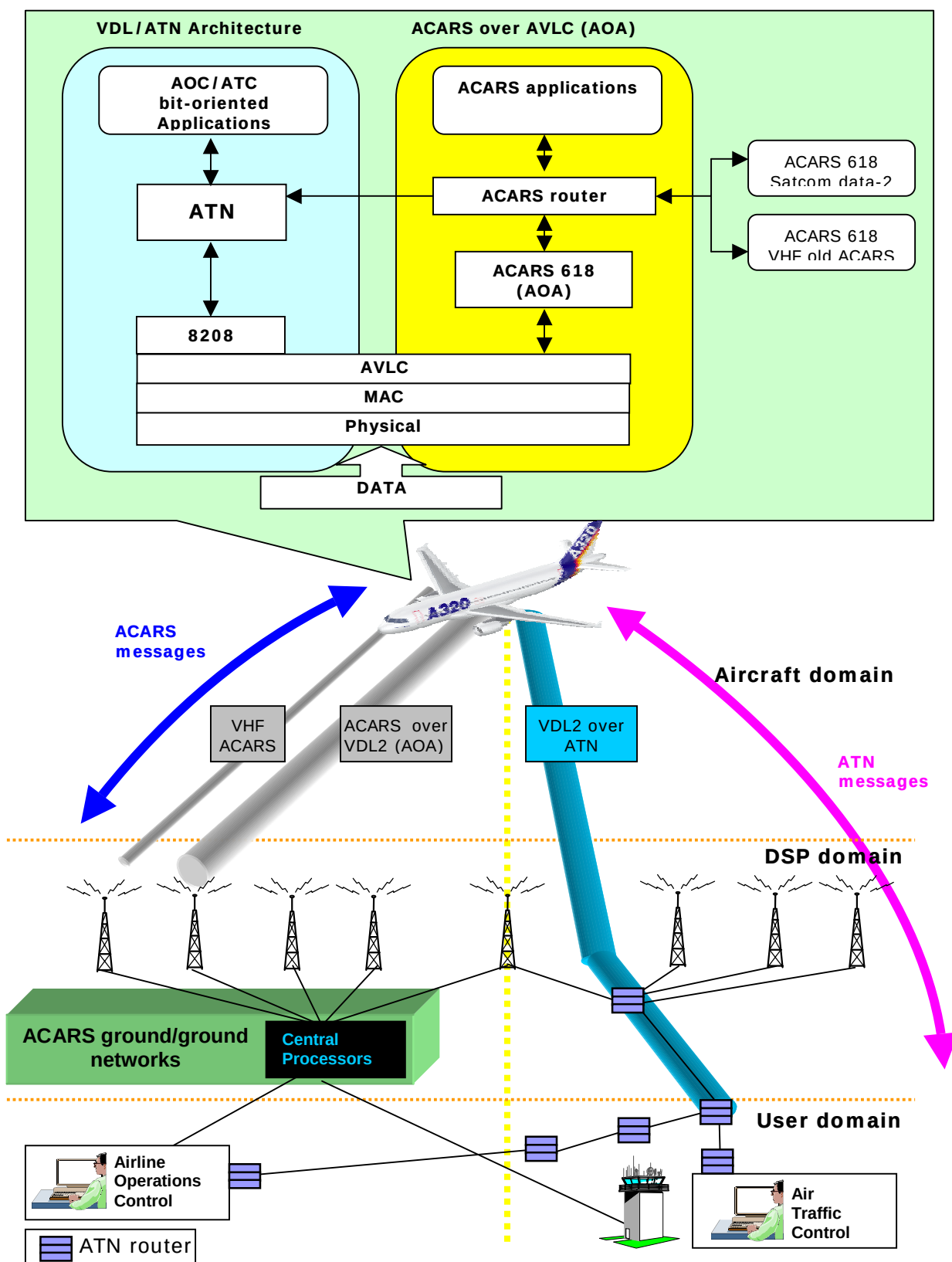


Figure 7.2:
Shared AOC and ATC network

7.4. ATN PROGRAMS AND OPERATIONS

7.4.1. PETAL-II AND LINK 2000+ EUROPEAN IMPLEMENTATION

The “PETAL II” & “PETAL II extension” trials have been used since 1996 to validate the concept, the infrastructures and the services of FANS-1/A and ATN at Maastricht UAC, including operational trials with commercial aircraft operating over an ATN compliant network.

The Link 2000+ program follows these trials and is the initial operational implementation of ATN in Europe.

The objective of the Link 2000+ Program is the deployment of operational mobile datalink services for ATC, and the supporting infrastructure, in the near and mid-term (refer Figure 7.3). The Program establishes the operational, technical and institutional basis for a scalable implementation and operation on a regional basis in Europe.

Note: As of today, the ATN system is fully operational in Maastricht UAC.

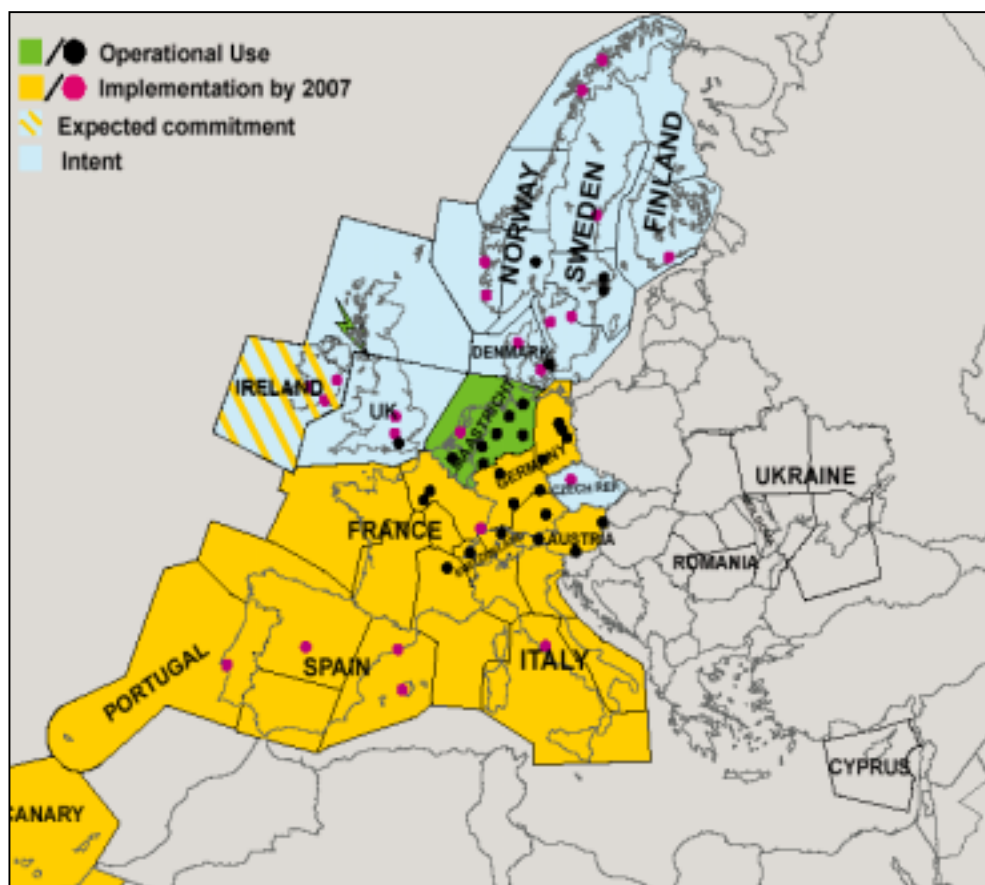


Figure 7.3:
Link2000+ program

Note: It is to be noticed that an ATN compliant network has been deployed and is also operated in Norway, to achieve platforms helicopters position reporting through the ADS application.

7.4.2. ATN US INITIAL IMPLEMENTATION

The FAA's CPDLC program, builds on from PETAL II, is being phased in terms of geographical scope (key site then national deployment), operational services (i.e. CPDLC messages) and supporting technical infrastructure (i.e. VDL). A total of 4 "builds" have been identified with the initial two (1 & 1A) best defined.

Build 1 was deployed at the Miami Control Center in 2002 and enables CM and CPDLC (refer to §7.3.1). The Build 1-A phase concerned the ATN deployment to 22 ATC centers of the continental USA.

Even though ATN is currently operated at the Miami ACC, the initial project schedule has been postponed and the deployment to the whole territory has been reschedule.

7.5. DATALINK OPERATIONS CONVERGENCE

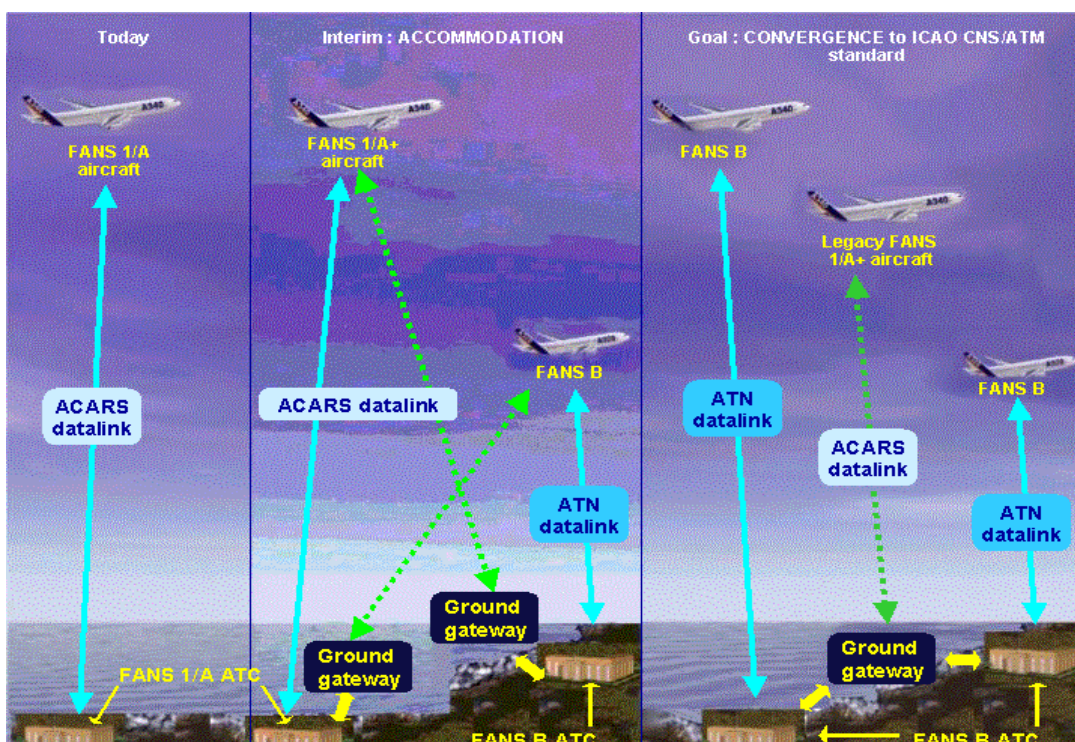


Figure 7.4:
Datalink accommodation & convergence

As shown on figure 7.4, Convergence to ICAO CNS/ATM standard will follow 2 steps:

- 1st step: "Accommodation phase"
In the interim, ground gateways will be used to accommodate aircraft with ATC centers that are not using the same standard. Thus, there are two kind of accommodation:
 - o FANS A aircraft with ATN ATC centers
 - o FANS B aircraft with FANS 1/A ATC centers
- 2nd step: "Convergence phase"
Global convergence in the long term to the ICAO CNS/ATM standard will require all ATC centres and aircraft migration to ATN systems.

7.6. CONCLUSION

7.6.1. ATN VS. ACARS

Network	ACARS FANS	ATN
Open	Proprietary	ISO/OSI
Global	Dedicated applications by needs	Common services to all users
Flexibility	Costly HW or SW implementations	Interfaces compliance for new applications or subnetworks
Evolutivity	Centralized architecture Private SITA/ARINC network	Deployment with existing subnets
Reliability	Best effort	End-to-end communication, security, system administration, multicast
Performance	Bit/character conversion Old technologies	Fully binary (voice,image,data)
Coverage	Worldwide infrastructure	Link 2K+ & Build1-A projects Global infrastructure to be done

Table 7.1:
ATN vs. ACARS

Compared to ACARS and FANS A, ATN is a **global standard**, which provides high data rate, high integrity, more reliable, and robust means for implementing current and future intensive datalink applications

7.6.2. COMING ATN

ATN specifies a global and evolutive infrastructure, based on well-known and proven technologies. It provides solutions to the shortcomings of the current ATS systems along with improved ATM services, reducing pilot and controller workload and voice channel congestion. Moreover, it provides a basis for evolutionary development of future ATM Network Independent applications

Thus, the ATN is coming as the specification is validated, and pre-operational and operational systems are being developed.

Please, bear in mind...

- ATN is a data communications internetwork that provides a common communications service for all ATC and AOC.
- The ATN Internet is made up the following functional components:
 - *End Systems* (provide the end-user applications)
 - *Intermediate Systems* (routers)
 - *Ground-Ground communication subnetworks*
 - *Air-Ground communication subnetworks*

The Internet approach was seen as the most suitable approach for ATN
At the beginning, ATN will be introduced only for ATC communications;
- ATN programs and operations
 - The Link 2000+ program is the initial operational implementation of ATN in Europe up to 2007.
 - ATN is currently operated at the Miami ACC but the initial project schedule has been postponed and the deployment to the whole territory has been reschedule after 2010.
- Datalink operations **convergence** will enable mixed fleets (ACARS datalink & ATN datalink-equipped aircraft) to operate with both ATN or ACARS ATC centers.

APPENDICES

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APPENDIX A

Standard Airbus AOC

1/ HONEYWELL ATSU Standard Airbus AOC

AOC Pre-Flight Menu System	AOC In-Flight Menu System	AOC Post-Flight Menu System
Flight Initialization Weather Request NOTAMS Request Winds Aloft Request Free Text Received Messages Send Loadsheet Request Voice Contact Request Miscellaneous Menu	In-Flight menu Weather Request NOTAMS Request Winds Aloft Request Free Text Received Messages Voice Contact Request Miscellaneous Menu Diversion Report Delay Report	Main Menu Send Connecting Gate Request Free Text Received Messages Delay Report Voice Contact Request Miscellaneous Menu

2/ Rockwell-Collins ATSU Standard Airbus AOC

<u>PREFLIGHT</u> Init Data Depart Delay Takeoff Delay <u>ENROUTE</u> Diversion Enroute Delay ETA In Range <u>POSTFLIGHT</u> Flt Summary Gate Delay	<u>REPORTS</u> Ops Rpt Other Rpt Dispatch Rpt Stations Rpt Ramp Svce Rpt Crew Rpt Maint Rpt Snag Rpt Misc Rpt <u>REQUESTS</u> Weather Req Wx Msg Type W/B Req	<u>MISC MENU</u> 7500 Rpt CFDIU/CMC Programming System Config Password Parameters Sensors Flt Log
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APPENDIX B

DATALINK FOR A SURVEILLANCE PURPOSE

1. - Mode S subnetwork

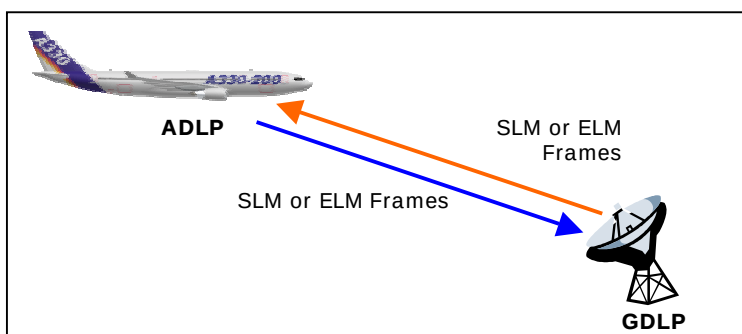
1.1 - Introduction

Mode Select (Mode S) is a type of monopulse Secondary Surveillance Radar (SSR) which enables direct addressing of individual aircraft via a so-called **“Mode S datalink”**. For the time being, the only operational use of Mode S datalink is in the Mode S transponder air-to-air mode used for the Airborne Collision Avoidance System (ACAS), operational since 1991. The **Enhanced Mode S** surveillance services, being planned for implementation in Europe and US, will use the addressed Mode S datalink for the **readout of various onboard data items**. Therefore, the Mode S SSR system provides both general (*broadcast*) surveillance and specific (*addressed* to a given aircraft) surveillance along with a data carrying capability, which will be utilized for the ATN (described chapter 7).

1.2 - Communication capability

On every scan of the radar interrogator, up to four *Standard Length Message (SLM)* frames, or one *Extended Length Message (ELM)* may be uplinked, respectively providing 28 bytes or 160 bytes of data transfer per scan. Similarly, the airborne transponder can transmit SLM, that contains control Mode S information (aircraft 24 bits address and parity bit to enable control of this aircraft), or Extended Squitter (ELM) that enables the aircraft to transmit, without external triggers, 162 bits-long messages (instead of 56 bits for Standard Squitter).

This data transfer capability is managed on the groundside by a *Ground Data Link Processor (GDLP)* and on the airborne side by an *Airborne Data Link Processor (ADLP)*. A GDLP may provide simultaneous communications paths to some or all aircraft currently under interrogation and may also support multiple interrogators with overlapping coverage. The data rate offered to each aircraft by Mode S is very dependent on the scanner rotation rate and the availability of overlapping interrogators managed by the same GDLP. Thus, with the current mechanical scanning, the data transfer rate may be no more than 200 bits/s. However, the actual data transfer rate is 1 to 4 Mbits/s and with the availability of Electronically Steerable Interrogators will provide a very capable service.



The very long development time of Mode S has impacted its credibility. During its development, monopulse radars have been introduced, which have mitigated many of the limitations of classical SSR, and this has reduced much of the need for Mode S. However, it does now appear that Mode S will be introduced for Surveillance, and equipment programs for Mode S are in place in both Europe and North America.

At the moment the support for the use of Mode S datalink seems to be little, due to the high equipment cost for both ground and air systems, and the low data rate available with mechanical scanners. Other alternatives, such as VDL, appear to offer more cost effective solutions.

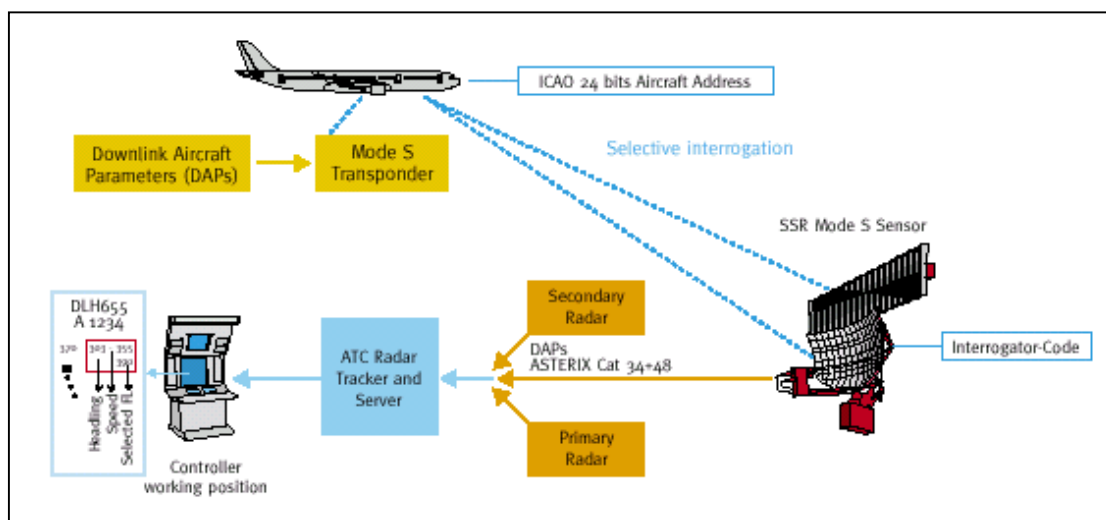
In the long term, **Mode S is the only available air/ground technology that offers the potential for megabit data transfer rates.** This can be achieved through the use of electronically scanned antennae, or even omni-directional antennae supported by steerable antennae and synchronized with adjacent interrogators.

1.3 - Elementary and Enhanced surveillance concepts

Traditional Secondary Surveillance Radar (SSR) stations interrogate via datalink all aircraft within their reach to obtain aircraft identification and altitude. Mode S SSR establishes selective interrogations, with aircraft within its coverage. Such selective interrogation improves the quality and integrity of the detection, identification and altitude reporting. These improvements translate into benefits in terms of safety, capacity and efficiency.

Mode-S Elementary and Enhanced concepts consist in the extraction by the ATC of further aircraft parameters known as Downlink Airborne Parameters (DAPs). The required Mode S transponder, has the ability to transmit up to 251 different sets of Downlinked Aircraft Parameters (DAP), which may include, for example, those relating to the aircraft's position, aircraft derived weather information or the aircraft's trajectory, all of which are or will be defined to support future applications and therefore offer potentials for future benefits.

Note: Detailed technical definitions of already defined parameters as well as potential additional parameters for future use are described in the ICAO Annex 10 Vol. III, Chapter 5.



1.4 - Benefits

1.4.1 - Air Traffic Controllers

Enhanced Surveillance, through the ground acquisition of specific aircraft parameters, will enable the air traffic controller to **increase their efficiency in tactically separating aircraft**. The controller's information is improved by providing actual aircraft derived data such as Magnetic Heading, Indicated Air Speed, Vertical Rate and Selected Altitude. This enables the controller to reduce their workload and frees them to concentrate on ensuring the safe and efficient air traffic.

1.4.2 - Pilots

Through the automatic extraction of an aircraft's parameters, Enhanced Surveillance will lead to a **reduction in radiotelephony** between the air traffic controllers and the pilots. This **reduces the workload** on a pilot and **removes a potential source of error**.

1.4.3 - Aircraft Operators

Enhanced Surveillance will support safety and efficiency **improvements to ATM operations**. For example, downlinking the Selected Altitude of aircraft will make a significant contribution to the prevention of inadvertent departures from the authorized flight level (level bust avoidance).

2 - Automatic Dependent Surveillance – Contract (ADS-C)

ADS-C equipped mobile stations automatically provide, via a **point-to-point datalink**, data derived from on-board navigation and position-fixing systems, including identification, four-dimensional position, and additional data as appropriate. The data are transmitted to one or more ground systems with which the mobile station has previously established a contract (agreement). An ADS Contract is an ADS reporting plan, which establishes the conditions of ADS data reporting (i.e., data required by the ground system and frequency of ADS reports which have to be agreed to prior to the provision of the ADS services). The terms of the contract are negotiated between the ground system and the mobile station. An ADS Contract would specify under what conditions ADS reports would be initiated, and what data would be contained in the reports.

The ICAO ADS can use any of the mobile subnetworks that offer a point-to-point air/ground data service compatible with ATN. Such sub-networks include satellite, VHF datalinks (VDL mode2, 3, 4), Mode S Datalink, and HF Datalink. It is to be noticed that FANS-A ADS can also operate over ACARS datalink.

Note: For further details on this application, refer to the “Getting to grip with FANS” brochure.

3 - Automatic Dependent Surveillance – Broadcast (ADS-B)

3.1 - General concept

ADS-B stands for Automatic Dependent Surveillance Broadcast.

Automatic - fully transparent to the crew (no pilot action required).

Dependant - uses accurate position and velocity data from aircraft's navigation system (e.g. GNSS).

Surveillance - provides aircraft position, altitude, velocity, and other data.

Broadcast - Any appropriately equipped ground station or aircraft can monitor the ADS-B signal.

ADS-B is a concept in which aircraft avionics automatically **broadcast** aircraft position, altitude, velocity and other data every second (or so) via a digital datalink. This data can be used by other aircraft and ATC to show the aircraft's position and altitude on display screens, without the need for radar.

RTCA has defined ADS-B as: "ADS-B is a function on an aircraft or surface vehicle that periodically broadcasts its state vector and other information."

ADS-B will allow pilots and air traffic controllers to "see" aircraft and vehicle traffic with more precision than has been possible ever before. This information is displayed on a CDTI (Cockpit Display of Traffic Information).



CDTI will provide the position (latitude, longitude, and altitude) and heading data for nearby aircraft. This data is displayed in the cockpit to augment the "see and avoid" concept. This data link capability can be achieved by using either an ground-based CDTI or an air-to-air CDTI. The benefit of using ground-based CDTI is that VFR aircraft can be displayed. The air-to-air application is independent from the ground system and, thereby, avoids problems with ground system availability and capacity.

Different from radar, which works by bouncing radio waves off of airborne targets and then "interpreting" the reflected signal, ADS-B uses the Global Navigation Satellite System (GNSS). Each ADS-B equipped aircraft or ground vehicle broadcasts its precise GNSS position via data-link along with other data, including speed, and, in the case of aircraft, altitude and whether it is turning, climbing or descending. This provides anyone with ADS-B equipment a much more accurate depiction of traffic than radar can provide.

Unlike radar, ADS-B works at low altitudes and on the ground, so that it can be used to monitor aircraft and vehicle traffic on the taxiways and runways of an airport. It is also effective in remote areas or in mountainous terrain where there is no radar coverage, or where radar coverage is limited. ADS-B receivers on the ground can relay aircraft position information in real time to airport ground controllers, approach controllers and En-route controllers.

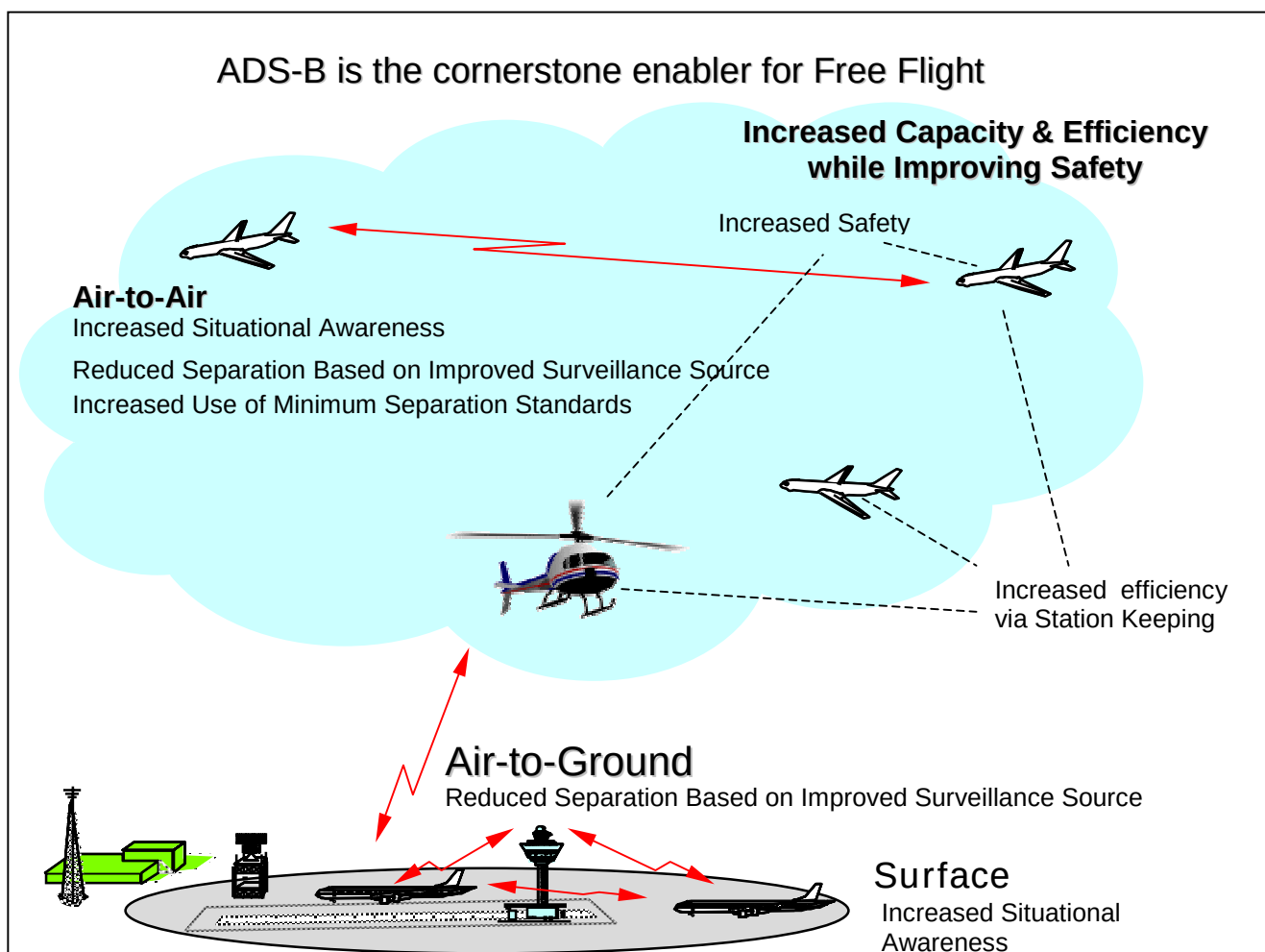
There is no ICAO ADS-B standard yet, although the ICAO ADS Panel mentions ADS-B in the manual of ATS Datalink Applications. Currently, there are three main candidate technologies available for ADS-B implementation:

- VHF Datalink Mode 4 (VDL-4), developed in Sweden
- Mode S (1090 MHz) Extended Squitter, based on Mode S Radar standards
- Universal Access Transceiver (UAT), supported by FAA

Standards are already in place for Mode S Ext. Squitter, whereas they are under development for VDL-4 and no standardization process has started yet for UAT.

The FAA has completed a technical and economic evaluation of the alternative ADS-B technologies. It has decided that ADS-B will use a combination of the 1090 MHz Extended Squitter ADS-B link for air carrier and private/commercial operators of high performance aircraft, and UAT ADS-B link for the typical general aviation user.

Note: For further information on these trials completed in Capstone (Alaska), refer to the following website: <http://www.alaska.faa.gov/capstone/>



APPENDIX C

DATALINK FOR A NAVIGATION PURPOSE

1 - Global Navigation Satellite System (GNSS) Augmentation systems

GNSS is a worldwide position, velocity, and time determination system that include one or more satellite constellations, receivers and system integrity monitoring, augmented as necessary to support the required navigation performance for the actual phase of operation. These constellations are **GPS** at present, and **GLONASS** (from 2006) and **GALILEO** (from 2008). In the aviation sector, GNSS has resulted in significant improve in En-route navigation and increases in overall system efficiency. Many airlines are installing GPS airborne receivers for use in En-route, terminal area, and non-precision approach operations

An augmentation system (such as SBAS, GBAS, ABAS) is a technique of providing the navigation system with information additional to that provided by the core GNSS satellite constellation, to afford a greater level of performance and more immediate warning of system errors. An augmentation system provides enhanced integrity using integrity data, and (for some) enhanced accuracy using differential corrections. The most commonly used augmentation system is ABAS.

To increase the integrity of GNSS signals, many FMS are already equipped with **Aircraft-Based Augmentation Systems** (ABAS). ABAS includes processing schemes which provide the integrity monitoring of the position solution using redundant information by using:

- GPS information redundancy to detect malfunctioning satellites, as the number of satellite and their configurations is usually better than necessary to compute a position. This technique is known as Receiver Autonomous Integrity Monitoring or RAIM;
- Information from additional onboard sensors such as IRS (Airborne Autonomous Integrity Monitoring - AAIM).

Most aircraft built by Airbus, since the mid-1990s have multi-sensor GPS/ABAS installations, routinely with RNP 0.3 certification, and deliverable with RNP 0.1 certification from 2004 onwards. These installations use data from the inertial and other navigation systems already on board the aircraft.

But, ABAS only provides an integrity monitoring whereas, GBAS and SBAS (detailed underneath) also provide to the user, differential corrections to improve the precision in a restricted area around a single reference station for GBAS and over a wide area defined by a network of reference stations for SBAS.

2 - Satellite-Based Augmentation System (SBAS)

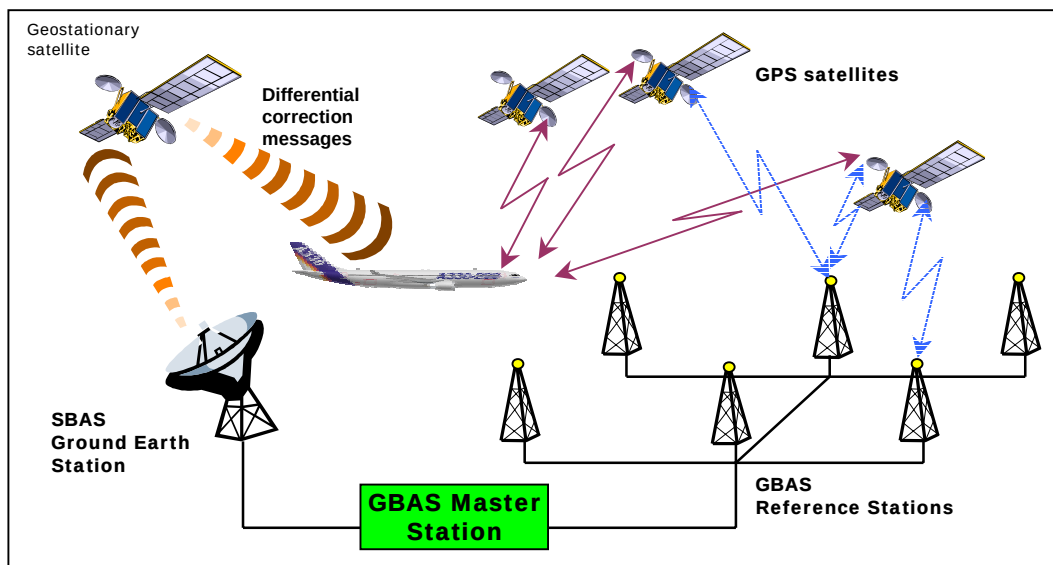
The SBAS is a combination of ground-based and space-based equipment to augment the standard positioning service of the GPS.

The functions being provided by SBAS are:

- *Differential corrections* (to improve accuracy)
- *Integrity monitoring* (to ensure that errors are within tolerable limits with a very high probability and thus ensure safety),
- *Ranging* (to improve availability).

Separate differential corrections are broadcast by SBAS through a **satellite datalink** to correct:

GPS satellite clock errors, ephemeris errors and ionospheric errors (ionospheric corrections are broadcast for selected area).



The GPS satellites' data are received and processed at Ground Reference Stations (GRS), which are distributed throughout countries. Data from the GRSS are forwarded to the Ground Master Station, which process the data to determine the differential corrections and bounds on the residual errors for each monitored satellite and for each area. The corrections and integrity information from the master station are then sent to each Ground Earth Stations and uplinked to the Geostationary Earth Orbiting Satellites, which downlink this data to the users

Europe (EGNOS, and in the future GALILEO), USA (WAAS) and Japan (MSAS) have developed their own SBAS systems, in the early nineties, and these should be available to aviation users by 2005-6. Other regions are also talking about providing SBAS services - Canada (CWAAS), India (GAGAN) and China (SNAS) - although their plans are less advanced. Brazil and the African continent have also shown a high level of interest.

3 - Ground-Based Augmentation System (GBAS)

The aviation community is also working to develop Ground-Based Augmentation System (GBAS) that will provide all-weather approach capabilities to aircraft within airport-line-of-sight distances via a Very High Frequency (VHF) datalink broadcast of GPS differential corrections.

Note: Using GBAS, the obtained correction is more precise than SBAS, but it is only addressed to aircraft around the airport (<30Nm).

APPENDIX D

ICAO SARPS ANNEX 10 STRUCTURE “AERONAUTICAL TELECOMMUNICATIONS”

The Annex 10 to the ICAO Convention is entitled “Aeronautical Telecommunications” and contains Standards And Recommended Practices (SARPs). Unless explicitly notified, ICAO member states guarantee that aircraft systems complying with ICAO standards will be compatible with the corresponding ground systems in their territory. The Annex 10 specifies for example the VHF voice protocol between aircraft and ground stations. The standard is relatively simple because it only specifies the analog encoding of voice on a radio signal in the VHF Aeronautical Band. In light of the increasing importance of aeronautical data communications, ICAO in 1995 created **Annex 10 Volume III Part I “Digital Data Communication Systems”**, which contains the following chapters:

- Chapter 1: Definitions
- Chapter 2: General
- Chapter 3: Aeronautical Telecommunications Network (ATN)
- Chapter 4: Aeronautical Mobile Satellite Service (AMSS)
- Chapter 5: SSR Radar Mode S Data Link
- Chapter 6: VHF Air-Ground Digital Link (VDL)
- Chapter 7: Subnetwork Interconnection (to be developed)
- Chapter 8: Aeronautical Fixed Telecommunications Network (AFTN)
- Chapter 9: Aircraft Addressing System
- Chapter 10: Point-to-Multipoint Communications
- Chapter 11: HF Data Link

Note: These chapters have been developed separately by different panels.

ICAO ATN Standard

Originally contained in Annex 10, Part I, Chapter 3, the ATN standards were later moved to ICAO Doc 9705 entitled “Manual of Technical Provisions for the aeronautical Telecommunication Network (ATN)”, which contains the following Sub-Volumes:

- Sub-Volume I: Introduction and system level requirements
- Sub-Volume II: Air-Ground Applications
 - Part 1: Context Management Application
 - Part 2: Automatic Dependent Surveillance Applications
 - Part 3: Controller Pilot Data Link Communication Application
 - Part 4: Flight Information Services Application
- Sub-Volume III: Ground-Ground Applications
 - Part 1: ATS Message Handling Services (ATSMHS)
 - Part 2: ATS Interfacility Data Communications
- Sub-Volume IV: Upper Layer Communications Service (ULCS)
- Sub-Volume V: Internet Communications Service (ICS).
- Sub-Volume VI: Systems management
- Sub-Volume VII: Directory service
- Sub-Volume VIII: Security services
- Sub-Volume IX: Identifier registration

APPENDIX E

ARINC SPECIFICATIONS

ARINC specification 618: Air/ground character-oriented protocol specification

This standard defines the Aircraft Communications Addressing and Reporting System (ACARS), a VHF datalink that transfers character-oriented data between aircraft systems and ground systems. This communications facility enables the aircraft to operate as part of the airlines command, control and management system.

ARINC specification 619: ACARS protocols for avionic end systems

This standard defines the protocols used by ACARS Management Units (MUs) defined in ARINC 597, 724 and 724B in their interactions with other onboard avionics equipment.

ARINC specification 620: Data link ground system standard and interface specification

This standard sets forth the desired interface characteristics of the data link service provider to the data link user. Provides data link users the information needed to develop applications and to encourage uniformity and standardization (to the extent possible) among various data link service providers. Contains general and specific guidance concerning the interfaces between the data link service providers and both the airborne and ground user.

ARINC specification 622: ATS over ACARS

Design guidance to developers, in order to ensure interoperability between implementations of ATS applications in both bit-oriented and character-oriented formats.

ARINC specification 623: Character-oriented air traffic service (ATS) applications

This standard defines the application text formats for character-oriented ATS messages that can be transmitted over the ACARS data link. Several ACARS data links are available, including but not limited to VHF, HF and satellite. The messages defined herein are not specific to any data link. This standard is limited in scope to character-oriented applications.

ARINC specification 631: VHF digital link implementation provisions **Functional Description**

This standard describes the functions to be performed by the airborne VHF Digital Link (VDL) to successfully transfer messages from VHF ground stations to avionics systems on aircraft and vice versa. The data is encoded in a bit-oriented format using the recommendations of the Open Systems Interconnection (OSI) Reference Model. ARINC 750 is a companion standard.

ARINC specification 632: Gate-Aircraft Terminal Environment Link (Gatelink) Ground Side

This standard contains necessary definitions and recommendations to implement the Gatelink ground system and infrastructure, and provide general and specific guidelines for development and installation of Gatelink systems and related communications infrastructure. Gatelink is defined as a high-speed, two-way communication link between a parked aircraft and a ground-based communications system.

ARINC specification 634: HF Data Link System Design Guidance Material

This standard provides the reader with material to enhance the understanding of high frequency data link. This standard provides a snapshot of guidance material used in the development of ARINC 753, HF Data Link System, and ARINC 635, HF Data Link Protocols.

ARINC specification 635-4: HF Data Link Protocols

This standard describes the functions to be performed by the airborne components of the HF DL to successfully transfer messages between HF ground stations and avionics systems on aircraft where the data is encoded in a bit-oriented format.

ARINC specification 637: Aeronautical telecommunications network implementation provisions

This standard provides general and specific design guidance for the development and installation of the ATN protocols and services needed to route and relay bit-oriented air-ground data link messages in an aviation environment. It applies principles defined in the Open Systems Interconnection (OSI) Reference Model.

ARINC characteristic 716: Airborne VHF communications transceiver

This standard sets forth characteristics of a VHF Communications Transceiver for installation in all types of commercial transport aircraft. The VHF transceiver can support 8.33 kHz or 25 kHz voice or ACARS (2400 bps) data communications.

ARINC characteristic 719-5: Airborne HF/SSB System

This standard sets forth characteristics of a new-generation HF/SSB System intended for installation in all types of commercial transport aircraft. Covers requirements for airborne transmitter-receiver equipment capable of transmitting and receiving HF radio intelligence.

ARINC characteristic 724b: Aircraft communications addressing and reporting system (ACARS)

This standard describes the “Mark 2” version of the ACARS equipment. It is intended for use in conjunction with existing airborne radio equipment to enhance air-ground operational control communications.

ARINC characteristic 741: Aviation Satellite Communication System

This standard provides general and specific guidance on the form factor and pin assignments for the installation of the Inmarsat Aero-H satellite terminal primarily for airline use. It includes the definition of multiple antennas to support multi-channel operation.

ARINC characteristic 750: VHF data radio

This standard specifies the form, fit and functional definitions for a VHF transceiver capable of voice and data communications. The VHF transceiver supports, 8.33 kHz and 25 kHz voice, and VDL-2 (31.5 kbps) data link communications as defined by ICAO. ARINC 631 is a companion standard.

ARINC characteristic 751: Gate-Aircraft Terminal Environment Link (Gatelink) - Aircraft Side

This standard describes the electrical and optical interface definitions for Gatelink communications. Gatelink is a 100 Mbps full-duplex communication link between a communication system inside the airport terminal (or at the maintenance position) and a communication system onboard a parked aircraft.

ARINC characteristic 753-3: HF Data Link System

The characteristics of a High Frequency Data Link (HFDL) communications system are defined by this standard. It defines avionic system components and the associated HF ground system. ARINC 634 and ARINC 635 are companion standards.

ARINC characteristic 758: Communications management unit (CMU)

This standard defines characteristics of a CMU Mark 2 used to route digital data link messages. The CMU Mark 2 is a tri-lingual device capable of ACARS communication, ARINC 622 data link communications and is capable of being expanded to provide Aeronautical Telecommunications Network (ATN) services.

APPENDIX F

LABELS / SUBLABELS

The ATSU receives messages information from the VDR3, the HF and the SDU. All uplink blocks whose address fields do not match the aircraft addresses are ignored. Uplink messages are processed either by the router itself, or directed to the appropriate hosted application or remote AOC peripherals, **according to the message label/sub-label**.

Similarly, the ATSU directs to the ground according to labels/sublabels messages received from peripherals or from the ATSU embedded software.

<p align="center">Single Aisle Aircraft PreFANS: "Enhanced router"</p>
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- **Downlink messages routing**

The ACARS router is able to generate the following downlink labels:

ACARS router downlink labels	
Label	Meaning
5P	Temporary suspension
DEL	General response
HX	Undelivered message
Q0	Link test
Q5	Unable to deliver message
Q6	Voice to data change advisory
QX	Intercept / unable to process.
SA	Media change advisory.
F3	Generated in response to label 54 uplink.

The ACARS router can accept downlinking any label other than labels generated by the other datalink users. For remote AOC applications, labels have been defined:

Downlink labels for ATSU peripherals		
Label	Sublabel	Peripheral
H1	M1	FM1
H1	M2	FM2
H1	DF	AIDS
H1	T1	CT1
H1	CF	CFDIU

Note: ARINC 620 is used.

- **Downlink messages priority**

The router sends the downlink messages according to their order of priority defined in the table below:

Level of priority	Source of the message (Label)
1	Protocolar messages (5P, F3, Q5, QX, _DEL)
2	Link establishment messages (Q0)
3	Messages Media Advisory (SA)
4	Essential ACARS messages (Q6,HX)
5	Router manager messages, Remote AOC messages (FMS)
6	Hosted AOC messages, Remote AOC messages (CFDIU, SDU1)
7	Remote AOC messages (AIDS)
8	Remote APC messages (Cabin Terminals)

- **Uplink messages routing**

Uplink messages are processed either by the router itself, or directed to the appropriate hosted application or remote AOC peripherals, **according to the message label/sub-label**: for uplink messages, the router determines which is the required destination by reading a specific label, and forwards the message to the correct application (hosted AOC, remote AOC, printer...).

The ACARS router will process on its own the following labels :

ACARS router uplink labels	
Label	Meaning
SQ	Message Squitter
::	Remote autotune
_DEL	General response
C1	Printer message
54	Voice Go-ahead ("COMPANY CALL")

When receiving an up-link message from the ground with label 54, ATSU sends the order to the FWS to generate the memo 'ACARS CALL'.

When receiving an uplink message from the ground with label C1, ATSU checks if the hosted AOC applications have required to process this message themselves. Else, the message is sent directly to the cockpit printer.

Uplink messages with label H1 are directed to the remote AOC applications in the corresponding peripheral: sublabels allow to direct the message to the appropriate system:

Uplink labels for ATSU peripherals		
Label	Sublabel	Peripheral
H1	M1	FM1
H1	M2	FM2
H1	MD	FM Master
H1	DF	AIDS
H1	T1	CT1
H1	CF	CFDIU

Hosted AOC applications define their own labels, and give this information to the ACARS router (it is contained in the AOC database). When receiving one of these uplink labels, for hosted AOCs only, the ATSU sends the FWS the order to generate the memo "ACARS MSG" on the ECAM.

All uplink blocks other than squitters (label SQ: messages with this label are sent to all aircraft, so there is no need for an aircraft address) and whose address fields do not match the aircraft addresses are ignored.

Long Range Aircraft FANS A

- **Uplink ACARS message processing**

The ACARS router will process on its own the following labels:

- **SQ** Message Squitter
- **::** Remote autotune
- **_DEL** General response
- **54** Voice Go-ahead. (used only to generate a 'F3' label)
- **C1** Printer message
- **A0** AFN uplink message
- **A6** ADS uplink message
- **AA** CPDLC uplink message

Messages with label H1 are directed to the remote AOC applications. Sublabels allow to direct the message to the appropriate peripheral.
Other labels are directed to hosted AOC applications. When receiving an up-link message from the ground, ATSU checks the label in order to generate the memo 'COMPANY CALL' if necessary.

- **Downlink ACARS message processing**

The ACARS router is able to generate the following downlink labels :

- **5P** Temporary suspension
- **_DEL** General response
- **HX** Undelivered message
- **Q0** Link test
- **Q5** Unable to deliver message
- **Q6** Voice to data change advisory
- **QX** Intercept / unable to process.
- **SA** Media change advisory.
- **F3** Dedicated transceiver
F3 is generated in response to label 54 uplink.
- **B0** AFN downlink message
- **B6** ADS downlink message
- **BA** CPDLC downlink message

APPENDIX G

OIT Ref.: SE 999 0004/04/VHR “Change for ARINC Europe base frequency for VDL”

FROM: AIRBUS CUSTOMER SERVICES TOULOUSE TX530526

OPERATOR INFORMATION TELEX - OPERATOR INFORMATION TELEX

TO: ALL AIRBUS AIRCRAFT TYPES - AIR TRAFFIC SERVICES UNIT
(ATSU) AND AIRCRAFT COMMUNICATIONS ADDRESSING AND REPORTING SYSTEM
(ACARS) USERS

SUBJECT: ATA 23/46 - CHANGE OF ARINC EUROPE BASE FREQUENCY FOR VHF DATALINK

OUR REF.: SE 999.0004/04/VHR DATED 09 JANUARY 2004

OIT CLASSIFICATION: MAINTENANCE AND ENGINEERING ADVICE

I/ PURPOSE

THE PURPOSE OF THIS OIT IS TO:

- ADVISE AIRBUS CUSTOMERS THAT ARINC EUROPE BASE FREQUENCY FOR VHF DATALINK (VDL) WILL MOVE FROM CURRENT 136.925 MHZ TO 131.825 MHZ BY 30-JUNE-2004

- PROVIDE GUIDELINES TO ARINC CUSTOMERS TO MAKE APPROPRIATE ATSU AND ACARS SETTINGS TO SUPPORT THE NEW FREQUENCY.

II/ BACKGROUND

ARINC HAS BEEN TASKED TO MOVE HIS EUROPEAN FREQUENCIES FOR VHF DATALINK (MODE 0/MODE A), BY THE ICAO FREQUENCY MANAGEMENT GROUP (FMG) IN THE FRAME OF HIS WORK TO CLEAR UPPER VHF BAND FOR VDL SERVICES IN EUROPE.

III/ IMPACT ON AIRCRAFT

III/A/ ACARS-EQUIPPED AIRCRAFT

WIDE BODY: A300/A310/A300-600

SINGLE AISLE: A319/A320/A321 (A318 EXCLUDED)

LONG RANGE: A330/A340 (A340-500/A340-600 EXCLUDED)

AIRBUS RECOMMENDS THE AIRLINES TO LIAISE WITH THEIR ACARS SUPPLIER IN ORDER TO GET THE CORRESPONDING ACARS UPGRADE TO HANDLE THE NEW FREQUENCY.

III/B/ ATSU-EQUIPPED AIRCRAFT

III/B/1

SINGLE AISLE: A319/A320/A321 (A318 EXCLUDED)
LONG RANGE: A330/A340 (A340-500/A340-600 EXCLUDED)

WITH AIRCRAFT INTERFACE SOFTWARE:

- VERSION CSB0.2B PN LA2T0S162C0C0F1 ON A319/A320/A321, MOD.27522 OR SB 46-1001 OR SB 46-1005 OR SB 46-1006 EMBODIED
- VERSION CLR2.4C PN LA2T0S10803G0F1 ON A330/A340, MOD 46742 OR SB A330-46-3001 OR SB A340-46-4005 EMBODIED
NO IMPACT, ARINC EUROPE NOT IMPLEMENTED.

III/B/2

SINGLE AISLE: A319/A320/A321 (A318 EXCLUDED)
LONG RANGE: A330/A340
WITH AIRCRAFT INTERFACE SOFTWARE:

- VERSION CSB1.1B PN LA2T0S111C1B0F1 ON A319/A320/A321, MOD 30239 OR SB 46-1009 EMBODIED
- VERSION CLR3.5B PN LA2T0S11105G0F1 ON A330/A340, MOD 47670 OR SB A330-46-3003 OR SB A340-46-4007 EMBODIED
- VERSION CLR3.6B PN LA2T0S11105J0F1 ON A330/A340 AND A340-500/-600, MOD 50323 SB A330-46-3011 OR SB A340-46-4011

IN THIS PARAGRAPH, "ARINC EUROPE" DESIGNATES THE CURRENT ARINC EUROPE FREQUENCY PROGRAMMING. "NEWARINCEU" DESIGNATES ARINC EUROPE FREQUENCY AFTER THE FREQUENCY MIGRATION.

THOSE ATSU SOFTWARE VERSIONS SUPPORT PROGRAMMING OF TWO USER DEFINED DATALINK SERVICE PROVIDER (DSP).

IT IS NECESSARY TO INPUT THE NEW ARINC EUROPE FREQUENCY AS A USER DEFINED DSP, USING THE FOLLOWING PARAMETERS (REFER TO AMM TASK 46-21-00-860-002 (A319/A320/A321) AND 46-21-00-860-803 (A330/A340) "PROCEDURE TO GET ACCESS TO THE DSP USER DEFINED PAGES"):

DSP NAME: "NEWARINCEU"
FREQUENCY: 131. 825MHZ
SQUITTER ID: XA
CATB: NO
SEC CHANNEL: NO
RETRY: 4
RETRY DELAY: 10/25

AIRLINES CAN ELECT ANY DSP NAME FOR INPUT IN THE CORRESPONDING FIELD ABOVE, BUT IT NEEDS TO OBEY THE FOLLOWING RULES:

- SIZE LIMITED TO 10 CHARACTERS
- ONLY CHARACTERS A TO Z AND NUMBERS 0 TO 9 (SPACE EXCLUDED) ARE ACCEPTED.

NOTE: USER DEFINED DSP PROGRAMMING MUST BE DONE AFTER EACH ATSU HARDWARE REPLACEMENT ON AIRCRAFT.

ONCE "NEWARINCEU" IS PROGRAMMED AS A USER DEFINED DSP, IT IS NECESSARY TO REPROGRAM THE SCANMASK ACCORDINGLY (REFER TO AMM TASK 46-21-00-860-001 (A319/A320/A321) AND 46-21-00-860-801 (A330/A340) "INITIALIZATION PROCEDURE OF THE ATSU ROUTER"):

- ERASE THE ATSU SCANMASK
- SELECT "NEWARINCEU" AND "ARINC EUROPE" IN THE SCAN MASK AND OTHER CONTRACTED DSP BY THE AIRLINE.

NOTE: AIRLINES CAN IMPLEMENT "NEWARINCEU" PROGRAMMING AHEAD OF ARINC EUROPE FREQUENCY CHANGE DATE, AND INPUT BOTH "ARINC EUROPE" AND "NEWARINCEU" IN THE SCANMASK. THIS WILL ENSURE TRANSPARENCY AROUND THE FREQUENCY MOVE DATE. IN THE SAME WAY, AIRLINES WILL BE ABLE TO MAINTAIN "ARINC EUROPE" IN THEIR SCANMASK AFTER THE TRANSITION, AND TO REMOVE IT FROM THE SCANMASK AT THEIR OWN CONVENIENCE. THE ABOVE ATSU ROUTER VERSIONS ALLOW SCANNING ON MULTIPLE DSP FREQUENCIES THUS THIS STATEMENT APPLIES TO ARINC CUSTOMERS HAVING A CONTRACT WITH SITA AS WELL.

A DEDICATED TASK FOR "NEWARINCEU" PROGRAMMING WILL BE INSERTED IN THE AMM:

- TASK 46-21-00-860-004 FOR A319/A320/A321
- TASK 46-21-00-860-805 FOR A330/A340.

THE ABOVE AMM REVISIONS WILL BE AVAILABLE IN MAY 2004 FOR A319/A320/A321 AND IN APRIL 2004 FOR A330/A340.

III/B/3

SINGLE AISLE: A318/A319/A320/A321

LONG RANGE: A330/A340

WITH AIRCRAFT INTERFACE SOFTWARE:

- VERSION CSB2.2B PN LA2T0J13000C0F1 ON A318/A319/A320/A321, MOD 31371 OR SB 46-1013 EMBODIED
- VERSION CSB3.2C PN LA2T0J13002C0F1 ON A318/A319/A320/A321, MOD 32494
- VERSION CLR4.6 PN LA2T0J13010G0F1 ON A330/A340, MOD 50076, EXPECTED FOR CERTIFICATION BY FIRST QUARTER 2004. CLR4.X, ALSO KNOWN AS FANS A+ STANDARD WILL BE OFFICIALLY ANNOUNCED TO THE AIRLINES VIA A SEPARATE OIT BY FIRST QUARTER 2004.

IN THIS PARAGRAPH, "OLD ARINC EUROPE" DESIGNATES THE CURRENT ARINC EUROPE FREQUENCY PROGRAMMING. "ARINC EUROPE" DESIGNATES ARINC EUROPE FREQUENCY AFTER THE FREQUENCY MIGRATION.

THOSE VERSIONS REQUIRE AN ATSU ROUTER PARAMETER SOFTWARE (FIN 30TX) UPGRADE TO SUPPORT THE FREQUENCY TRANSITION. AIRBUS-FRANCE, THE ATSU MANUFACTURER, WOULD PROVIDE THE ATSU ROUTER PARAMETER SOFTWARE CUSTOMIZATION SERVICE BY:

- CSB2.2B: END OF MARCH 2004
- CSB3.2C: END OF APRIL 2004
- CLR4.6 WILL BE BASICALLY DELIVERED WITH ATSU ROUTER PARAMETER DATABASE FEATURING DUAL ARINC FREQUENCY PROGRAMMING.

ATSU ROUTER PARAMETER DATABASE SUPPLY (FLOPPY DISK - FIN 30TX) WILL BE ASSOCIATED WITH VSB LA2T0-46-011 EXPECTED FOR DISPATCH BY END OF MARCH 2004. ORDERS SHOULD BE ADDRESSED TO:

AIRBUS FRANCE S.A.S.
AVIONICS AND SIMULATION PRODUCTS
M65 BUILDING - STATION TIT UM 654 - .316 ROUTE DE BAYONNE
31060 TOULOUSE CEDEX 03
FRANCE
TEL: +33/(0)5 61 93 55 55
FAX: +33/(0)5 61 18 04 94

IN ORDER TO MANAGE ARINC EUROPE FREQUENCY TRANSITION, AIRBUS- FRANCE WILL DEVELOP NEW DATABASES COMPATIBLE WITH THE ABOVE ATSU SOFTWARE VERSIONS THAT WILL CONTAIN BOTH "OLD ARINC EUROPE" AND "ARINC EUROPE" FREQUENCIES.

TWO DSP'S CURRENTLY PROVIDE DATALINK SERVICES OVER EUROPE, ARINC AND SITA.
THE ATSU ROUTER ALLOWS ASSIGNMENT OF TWO DSP PER WORLDMAP REGION, A MAIN AND A BACKUP. THEREFORE:

- ARINC ONLY CUSTOMERS WILL BE ABLE TO SELECT BOTH "OLD ARINC EUROPE" AND "ARINC EUROPE" IN THE SCANMASK AS SOON AS THEY GET THE NEW ATSU ROUTER PARAMETER DATABASE, AHEAD OF THE FREQUENCY CHANGE DATE
- AIRLINES BEING CUSTOMERS OF BOTH ARINC AND SITA WILL NEED TO:
 - OBTAIN THE NEW ATSU ROUTER PARAMETER DATABASE
 - SELECT "OLD ARINC EUROPE" AND SITA EUROPE IN THE SCAN MASK BEFORE THE FREQUENCY CHANGE DATE
 - SELECT "ARINC EUROPE" AND SITA EUROPE IN THE SCAN MASK AT THE FREQUENCY CHANGE DATE.

IV/ FOLLOW-UP PLAN

NO SPECIFIC FOLLOW-UP OF THIS OIT IS PLANNED.

QUESTIONS ABOUT THE TECHNICAL CONTENT OF THIS OIT ARE TO BE ADDRESSED TO:
MR. C. CASSIAU-HAURIE, DEPT. SEE4,
PHONE +33/(0)5 62 11 05 25,
FAX +33/(0)5 61 93 44 25.

BEST REGARDS,

P. GLAPA
VICE PRESIDENT, SYSTEMS AND POWERPLANT
ENGINEERING SERVICES
CUSTOMER SERVICES DIRECTORATE

APPENDIX H

OIT/FOT Ref.: SE 999.0042/04/VHR **“A330/A340 – ATA46 - New ATSU software named FANS A plus”**

FROM : AIRBUS CUSTOMER SERVICES TOULOUSE TX530526

OPERATORS INFORMATION TELEX - OPERATORS INFORMATION TELEX
AND
FLIGHT OPERATIONS TELEX - FLIGHT OPERATIONS TELEX

TO : ALL A330/A340 ATSU (AIR TRAFFIC SERVICES UNIT) USERS

SUBJECT : A330/A340 - ATA 46 -NEW AIR TRAFFIC SERVICES UNIT
(ATSU) SOFTWARE NAMED ''FANS A PLUS''

OUR REF.: SE 999.0042/04/VHR DATED 15 APR 2004

OIT CLASSIFICATION:
ENGINEERING AND FLIGHT OPERATIONS ADVICE

I/ PURPOSE

THE PURPOSE OF THIS OIT IS TO ADVISE OUR CUSTOMERS OF:

- THE UPCOMING CERTIFICATION OF ATSU SOFTWARE NAMED ''FANS A PLUS'', EXPECTED BY THE END OF APRIL 2004.
- ''FANS A PLUS'' CHARACTERISTICS.
- THE NEED TO ORDER AIRLINE OPERATIONAL CONTROL (AOC) SOFTWARE COMPATIBLE WITH ''FANS A PLUS''.
- NEW OPERATIONAL PERSPECTIVES INTRODUCED BY ''FANS A PLUS'':
 - . ACCOMMODATION OF ''FANS A PLUS'' AIRCRAFT BY CONTINENTAL ATC CENTERS IN DENSE TRAFFIC ENVIRONMENT.
 - . FANS OPERATIONS USING HIGH FREQUENCY DATA LINK (HFDL) AS A SUPPLEMENTAL MEANS OF COMMUNICATION WHEN OPERATIONALLY APPROVED.

II/ ''FANS A PLUS'' DESCRIPTION

''FANS A PLUS'' INTRODUCES SEVERAL ENHANCEMENTS TO THE ''FANS A'' CURRENTLY IN SERVICE, AMONG WHICH:

- ADVANCED DATALINK ROUTER.
- CAPACITY TO USE NEW COMMUNICATION MEDIA.
- ATC APPLICATIONS ENHANCEMENTS.
- CAPACITY TO SUSTAIN NEW ATC DATALINK FUNCTIONS.

THOSE ARE DETAILED HEREAFTER.

''FANS A'' UPGRADE TO ''FANS A PLUS'' CONSISTS IN A SOFTWARE CHANGE.

II.A/ ''FANS A PLUS'' BASIC FEATURES

**** AIRCRAFT INTERFACE SOFTWARE**

THE FOLLOWING CHANGES HAVE BEEN IMPLEMENTED TO THE AIRCRAFT INTERFACE SOFTWARE CLR3.5B/CLR3.6B TO CREATE CLR4.6:

- MODIFICATION OF ATSU ROUTER FREQUENCY SELECTION ALGORITHM, USING AN INTERNAL DSP (DATALINK SERVICE PROVIDER) COVERAGE WORLD MAP FOR VHF DATALINK.
- DATABASE CUSTOMIZATION CAPACITY FOR:
 - . ATSU ROUTER INITIALIZATION (SCAN MASK AND AIRLINE ID), SERVICE AVAILABLE IMMEDIATELY AFTER CERTIFICATION
 - . AND WORLDMAP, SERVICE EXPECTED BY THE END OF JUNE 2004.
- CAPACITY TO SUPPORT VDL (VHF DATALINK) MODE 2 OVER ACARS NETWORK.
- BITE IMPROVEMENT.
- CAPACITY TO HOST ATC623 APPLICATIONS.
- CAPACITY TO SUPPORT HIGH SPEED DATALOADING IN SHOP AND ON BOARD.
- EASED DATALOADING OF APPLICATIONS IN ''NORMAL SPEED'' MODE.
- ATC MESSAGES ROUTING OVER HFDL (HF DATA LINK) AS A TERTIARY DATALINK MEDIA. HFDL BECOMES A SUPPLEMENTAL MEANS IN ADDITION TO VHF AND SATCOM THAT ARE PRIMARY MEANS OF COMMUNICATION.
- INHIBITION OF VHF3 SWITCHING IN VOICE MODE FROM THE MCDU WHEN ATC APPLICATIONS INSTALLED.
- INTRODUCTION OF HUMAN-MACHINE INTERFACE ENHANCEMENTS (VIA MCDU) FOR MORE USER-FRIENDLINESS OF ATC AND AOC FUNCTIONS.
- CAPACITY TO OVERRIDE FLIGHT NUMBER IN DOWNLINK HEADER (REQUIRES AN AOC SOFTWARE CUSTOMIZATION).

NOTE: CLR4.6 BENEFITS FROM THE IMPROVEMENTS MADE IN CLR3.6B TO RESOLVE AUTOMATIC DEPENDANT SURVEILLANCE (ADS) ISSUES (REFER TO OIT/FOT SE 999.0001/03/VHR DATED 07 JAN 2003).

**** ''FANS A PLUS'' ATC APPLICATIONS**

''FANS A PLUS'' APPLICATIONS ARE COMPOSED OF ATS FACILITIES NOTIFICATION (AFN), ADS, AND CONTROLLER PILOT DATALINK COMMUNICATION (CPDLC).

THE FOLLOWING ENHANCEMENTS HAVE BEEN IMPLEMENTED TO CREATE ''FANS A PLUS'' ATC APPLICATIONS:

- DISPLAY OF CONNECTED ATC CENTERS FOR ADS AND POSSIBILITY TO DISCONNECT THEM INDIVIDUALLY.

- IMPLEMENTATION OF THE MESSAGE LATENCY FUNCTION (ALSO CALLED 'MAX UPLINK DELAY') FOR CPDLC TO ALLOW 'FANS A PLUS' AIRCRAFT USE IN DENSE TRAFFIC CONTINENTAL AIRSPACE (ACCOMMODATION IN MAASTRICHT INITIALLY).
- IMPLEMENTATION OF THE CPDLC FEATURES:
 - . 'BACK ON ROUTE' MESSAGE (DL 41).
 - . 'EITHER SIDE OFFSET' (I.E. NO DIRECTION SPECIFIED) FOR WEATHER DEVIATION REQUEST (DL 27).
- GENERAL ENHANCEMENTS OF THE ATC HUMAN MACHINE INTERFACE (DCDU/MCDU).

II.B/ OPTIONAL FEATURES

** ATC623 APPLICATION PACKAGE

AIRBUS IMPLEMENTATION OF THE FOLLOWING ATC DATALINK APPLICATIONS (THAT WERE ORIGINALLY DEFINED PER ARINC623 SPECIFICATION):

- DCL: DEPARTURE CLEARANCE COMPLYING WITH ED-85.
- OCL: OCEANIC CLEARANCE COMPLYING WITH ED-106.
- ATIS: (AUTOMATIC TERMINAL INFORMATION SERVICE) COMPLYING WITH ED-89.

CHARACTERISTIC OF AIRBUS IMPLEMENTATION IS THE USE OF THE DCDU (DATALINK CONTROL AND DISPLAY UNIT) FOR OCEANIC & DEPARTURE CLEARANCE MESSAGES, FULLY IN LINE WITH CPDLC MESSAGE DISPLAY PHILOSOPHY.

ATIS IS ACCESSIBLE THROUGH MCDU.

** HFDL (HF DATALINK)

HFDL PROVIDES WORLDWIDE DATALINK COVERAGE, AND IS THE SOLE DATALINK MEDIA PROVIDING CONTINUOUS COVERAGE OVER THE ARCTIC REGION.

HFDL IS AVAILABLE WITH 'FANS A' FOR AOC MESSAGING ONLY. 'FANS A PLUS' ENABLES ATC DATALINK (AFN, ADS, CPDLC AND ATC623) ROUTING OVER HFDL AS A TERTIARY DATALINK MEDIA, IN ADDITION TO VHF AND SATCOM.

** VHF DATA LINK (VDL) MODE 2

VDL MODE 2 PROVIDES HIGH SPEED DATALINK (31.5 KILOBITS PER SECOND) OVER ACARS NETWORK COMPARED TO FORMER VDL MODE A (2.4 KILOBITS PER SECOND).

VDL MODE 2 SERVICES, PROVIDED BY ARINC, SITA AND AVICOM, ARE CURRENTLY AVAILABLE OVER EUROPE, NORTH AMERICA AND JAPAN.

** HIGH SPEED DATALOADING

UPLOADING OF THE ATSU SOFTWARE PER ARINC 615A PROTOCOL IS FIVE TIMES FASTER THAN WITH CURRENT ARINC 615-3.

HIGH SPEED DATALOADING ALSO ALLOWS FULL AUTOMATION OF THE DATALOADING SEQUENCE THUS REDUCES MAINTENANCE PERSONNEL WORKLOAD.

IT REQUIRES A HIGH SPEED DATA LOADER, TO BE ORDERED FROM PORTABLE DATA LOADER SUPPLIERS.

II.C/ ATSU CONFIGURATIONS

** 'FANS A PLUS' IS COMPATIBLE WITH THE FOLLOWING ATSU HARDWARE (1TX1):

- PN LA2T0G20503B040
- PN LA2T0G20503B050
- PN LA2T0G20705C070 (HIGH SPEED DATALODING CAPABLE)

** 'FANS A PLUS', STANDARD CLR4.6, AIRCRAFT INTERFACE / CONFIGURATION SOFTWARE PACKAGE IS COMPOSED OF:

- AIRCRAFT INTERFACE SOFTWARE PN LA2T0J13010G0F1 (20TX).
- ATSU CONFIGURATION SOFTWARE PN LA2T0J60003X0F1 (21TX).
THE CONFIGURATION SOFTWARE PART NUMBER (VARIABLE X) DEPENDS ON THE OPTIONS SELECTED BY THE AIRLINE.

- ATSU ROUTER PARAMETER SOFTWARE PN LA2T0J00003B0F1 (30TX).
THIS ATSU ROUTER PARAMETER SOFTWARE CONTAINS THE NEW ARINC EUROPE FREQUENCY (REFER TO OIT SE 999.0004/04).

** 'FANS A PLUS' ATC APPLICATIONS PACKAGE IS COMPOSED OF:

- ATC UTILITIES (ATC HUMAN MACHINE INTERFACE MANAGER) PN LA2T0K00000J0F1 (25TX).
- ATC 'FANS A' APPLICATIONS (AFN, ADS AND CPDLC) PN LA2T0K20000F0F1 (35TX).

** ATC 623 APPLICATIONS PACKAGE

- ATC 623 APPLICATIONS (ATIS, OCL, DCL) PN LA2T0K10000H0F1 (23TX).

** THE AOC VALIDATED BY AIRBUS (CALLED STANDARD AOC) COMPATIBLE WITH AIRCRAFT INTERFACE SOFTWARE CLR4.6 PN LA2T0J13010G0F1 HAVE THE FOLLOWING PN:

- HONEYWELL AOC:

APPLICATION SOFTWARE (22TX): PN 998-2459-507
DATABASE (24TX): PN 998-2449-505

- ROCKWELL COLLINS AOC:

GLOBAL ROCKWELL COLLINS AOC SOFTWARE PN: 822-1451-005.
APPLICATION SOFTWARE (22TX): PN 222-6279-232.RVA.
DATABASE (24TX): PN 222-5870-532.RVC.

THE ABOVE AOC SOFTWARE ARE HIGH-SPEED DATALOADABLE PROVIDED HIGH SPEED DATALODING IS ACTIVE ON THE AIRCRAFT.

THESE AOC'S ARE COMPATIBLE WITH A318/A319/A320/A321 AIRCRAFT INTERFACE SOFTWARE VERSION CSB2.2B PN LA2T0J13000C0F1 AND WITH CSB3.2C PN LA2T0J13002C0F1. THOSE CAN THUS BE USED ON EITHER SINGLE AISLE OR LONG RANGE AIRCRAFT FAMILIES.

NOTE:

THE ATSU AIRCRAFT INTERFACE SOFTWARE IS CERTIFIED BY AIRBUS AT LEVEL C (AS PER D0178B), TO HAVE THE CAPABILITY TO HOST USER MODIFIABLE SOFTWARE (REFER TO SIL 00-063). IT MEANS THAT A CHANGE TO THE AOC APPLICATION OR DATABASE SOFTWARE DOES NOT IMPACT THE CERTIFICATION OF THE AIRCRAFT INTERFACE SOFTWARE.

III/ ''FANS A PLUS'' FITTING ON AIRCRAFT

III.A/ FORWARD FIT

''FANS A PLUS'' WILL BE BASIC ON PRODUCTION AIRCRAFT FROM 1ST QUARTER 2005 (MSN RANK TO BE DEFINED LATER). AIRLINES WISHING EARLIER EMBODIMENT OF ''FANS A PLUS'' ON THEIR AIRCRAFT IN PRODUCTION MUST USE THE RFC PROCEDURE.

''FANS A PLUS'' OPTIONS, I.E. VDL MODE 2, HFDL, ATC 623 AND HIGH SPEED DATALODING MUST BE ORDERED VIA RFC.

III.B/ RETROFIT

''FANS A PLUS'' AND ASSOCIATED OPTIONS MUST BE ORDERED VIA RFC.

NOTE: IT IS RECOMMENDED TO ASSOCIATE ''FANS A PLUS'' RETROFIT WITH FMS P2 RETROFIT, IF NOT ALREADY DONE, TO BENEFIT FROM FULL ADS POSITION REPORTING IMPROVEMENTS (REFER TO OIT/FOT SE 999.0001/03/VHR DATED 07 JAN 2003).

IV/ ENGINEERING RECOMMENDATIONS

IV.A/ COMPATIBLE AOC PROCUREMENT

AIRLINES WHOSE AIRCRAFT WILL BE FITTED IN PRODUCTION OR IN RETROFIT WITH ''FANS A PLUS'' WILL NEED TO ORDER COMPATIBLE AOC SOFTWARE, EITHER STANDARD AOC (REFER TO PARAGRAPH II.C) OR CUSTOMIZED AOC, FROM THEIR AOC SUPPLIER.

IV.B/ ''FANS A PLUS'' POTENTIAL IMPACT ON AOC CUSTOMIZATION

IV.B.1/ COMPANY CALL AND VHF3 VOICE DIRECTORY

AIRLINES CURRENTLY USING THE FOLLOWING FUNCTIONS FOR THEIR COMMUNICATIONS:

VOICE GO AHEAD (LABEL 54) ALSO CALLED COMPANY CALL ON AIRBUS
VHF3 VOICE DIRECTORY

MUST REQUEST A CUSTOMIZATION FROM THEIR AOC SUPPLIER TO KEEP THE CAPACITY TO HANDLE THOSE FUNCTIONS, BECAUSE OF THE INHIBITION OF ATSU COMMAND FOR VHF3 SWITCHING IN VOICE.

IV.B.2/ FLIGHT NUMBER OVERRIDE

ALSO, AIRLINES WISHING TO BENEFIT FROM THE CAPACITY TO OVERRIDE THE FLIGHT NUMBER IN DOWNLINK HEADER BY THE ONE INITIALIZED IN THE AOC, WILL NEED TO REQUEST AN AOC SOFTWARE CUSTOMIZATION.

IV.B.3/ DOWNLINK MESSAGES ROUTING POLICY

AOC AND ATC MESSAGES ROUTING POLICY IS SET BY AIRBUS AS FOLLOWS:

VDL MODE 2 (IF ACTIVATED), VDL MODE A, SATCOM DATALINK, AND THEN HF DATALINK (IF ACTIVATED).

THE ROUTING POLICY FOR AOC MESSAGES ORIGINATED FROM EITHER THE AOC SOFTWARE OR FROM ATSU PERIPHERALS IS MODIFIABLE VIA THE AOC DATABASE (ATC MESSAGES ROUTING POLICY IS NOT USER-MODIFIABLE). AIRLINES WISHING TO MODIFY AOC MESSAGING ROUTING POLICY ARE ENCOURAGED TO REQUEST THE CORRESPONDING CHANGE FROM THEIR AOC SUPPLIER.

IV.B.4/ ATC623 USERS: REMOVAL OF ATIS, OCL, AND DCL FROM THE AOC APPLICATION

AIRLINES ALREADY USING AOC623 APPLICATIONS, AND WILLING TO IMPLEMENT AIRBUS ATC623 APPLICATIONS NEED TO ASK REMOVAL OF ATIS, OCL, AND DCL FROM THE AOC APPLICATION, IF THOSE ARE IMPLEMENTED, FROM THEIR AOC SUPPLIER. INDEED, EVEN THOUGH AIRBUS TOOK APPROPRIATE ACTIONS TO ENSURE ATC623/AOC623 COHABITATION, IT IS RECOMMENDED TO REMOVE FUNCTIONS/LABELS:

A1/B1/B2: OCEANIC CLEARANCE: PROVIDE/REQUEST/READBACK.
A3/B3/B4: DEPARTURE CLEARANCE PROVIDE/REQUEST/READBACK.
A4: FLIGHT SYSTEM MESSAGE.
A9/B9: PROVIDE/REQUEST ATIS REPORT.

NOTE THAT OTHER AOC623 FUNCTIONS SUCH AS TWIP (TERMINAL WEATHER INFORMATION FOR PILOTS), TAXI AND PUSHBACK CLEARANCES CAN BE KEPT ACTIVE IN THE AOC, SINCE NOT IMPLEMENTED IN THE ATC623 APPLICATION PACKAGE.

V/ OPERATIONAL PERSPECTIVES

V.A/ ''FANS A PLUS'' AIRCRAFT OPERATIONS WITH CONTINENTAL CENTER

EUROPE HAS SET UP A PROGRAM FOR ''FANS A/FANS A PLUS'' AIRCRAFT ACCOMMODATION IN DENSE TRAFFIC CONTINENTAL AIRSPACE. THIS SERVICE IS ALREADY OPERATIONAL IN MAASTRICHT CONTROL AREA. VOICE READBACK IS CURRENTLY REQUIRED IN THE FRAME OF THE ACCOMMODATION, HOWEVER THE ''MAX UPLINK DELAY'' (ALSO CALLED ''MESSAGE LATENCY'') FUNCTION IS EXPECTED IN THE MEDIUM TERM TO ALLEVIATE THIS CONSTRAINT. INDEED, THE ''MAX UPLINK DELAY'' FUNCTION PREVENTS PILOTS FROM EXECUTING A CLEARANCE CONTAINED IN A DELAYED UPLINK.

MAASTRICHT EN-ROUTE CONTROL CENTER WILL SET UP TRIALS BY THIRD QUARTER 2004 WITH PIONEER AIRLINES TO ASSESS THE MAX UPLINK DELAY FUNCTION EFFICIENCY.

AIRLINES WISHING TO APPLY FOR ''MAX UPLINK DELAY'' TRIALS SHOULD CONTACT:

- AIRBUS UPGRADE SERVICES VIA THE RFC CHANNEL TO REQUEST FLEET UPGRADE TO ''FANS A PLUS''.
- EUROCONTROL IN ORDER TO REGISTER FOR THE TRIALS WITH MAASTRICHT.

NOTE THAT FOR IMPROVED TIMELINESS OF MESSAGES DELIVERY, AIRBUS WOULD RECOMMEND CANDIDATE AIRLINES TO CONSIDER VDL MODE 2 RETROFIT.

V/B FANS OPERATIONS USING HF DL AS A SUPPLEMENTAL MEANS OF COMMUNICATION

HF DL IS BEING PUSHED FOR OPERATIONAL APPROVAL AS A TERTIARY MEANS FOR ATC DATALINK IN EXISTING FANS AIRSPACES. THIS OPERATIONAL PERSPECTIVE HAS CONDUCTED AIRBUS TO CERTIFY ATC DATALINK OVER HF DL IN ''FANS A PLUS'', AS A SUPPLEMENTAL MEANS OF COMMUNICATION, IN FULL CONSISTENCY WITH GROUND NETWORKS MEDIA PRIORIZATION (ROUTING POLICY).

VI/ ADDITIONAL INFORMATION

IN VIEW OF FANS A GROUND IMPLEMENTATION SPREADING IN REGIONS WHERE SINGLE AISLE AIRCRAFT OPERATE (TASMAN SEA, CONTINENTAL CHINA), AND WITH THE INCREASING INTEREST EXPRESSED BY THE AIRLINES, AIRBUS WILL CERTIFY ''FANS A PLUS'' AND ASSOCIATED OPTIONS ON THE SINGLE AISLE AIRCRAFT FAMILY BY FIRST QUARTER 2005. ''FANS A PLUS'' WILL BE AN OPTION.

VII/ REFERENCED DOCUMENTS

FOR FURTHER INFORMATION ON ''FANS A PLUS'', PLEASE REFER TO
- AIRBUS FLIGHT OPERATIONS BROCHURE ''GETTING TO GRIPS WITH FANS'' SEPTEMBER 2003 REVISION.
- ''THE FANS A PLUS STANDARD'' DOCUMENT PRESENTED AT THE 12TH PERFORMANCE AND OPERATIONS CONFERENCE HELD IN ROME IN 2003.

VIII/ FOLLOW-UP PLAN

NO SPECIFIC FOLLOW-UP OF THIS OIT IS PLANNED.

QUESTIONS ABOUT THE TECHNICAL CONTENT OF THIS OIT ARE TO BE ADDRESSED TO MR. C. CASSIAU-HAURIE, DEPT. SEE4, PHONE +33/(0)5 62 11 05 25, FAX +33/(0)5 61 93 44 25.

QUESTIONS CONCERNING THE OPERATIONAL CONTENT OF THIS FOT ARE TO BE ADDRESSED TO MRS. MARIA PINILLA-MELGAREJO, DEPT. STLS/ PHONE +33/(0)5 61 93 40 53, FAX +33/(0)5 61 93 29 68.

BEST REGARDS.

P. GLAPA
VICE PRESIDENT
SYSTEMS & POWERPLANT
ENGINEERING SERVICES
CUSTOMER SERVICES DIRECTORATE

C. MONTEIL
VICE PRESIDENT
FLIGHT OPERATIONS
SUPPORT & LINE CUSTOMER
ASSISTANCE

APPENDIX I

DARP

DYNAMIC AIRBORNE ROUTE PLANNING

The dynamic re-routing procedure has been developed by the ISPACG forum to provide FANS equipped aircraft with the possibility of a complete F-PLN change once airborne. On the typical Los Angeles/Sydney or Los Angeles/Auckland routes, the wind updates after the first hours of flight may happen to show that a better F-PLN could be considered.

Procedures, based on an extensive use of the data link capabilities of the three AOC, ATC and aircraft, have thus been developed to allow for the crew to get an in-flight route re-clearance. The DARP scenario is described in the Airbus AIM-FANS A training CDROM. The following describes the SPOM (South Pacific Operating Manual) procedures, for a single re-route per flight, as currently in use.

1- Prerequisites

- The airline shall have an AOC data link capability to communicate with both the aircraft and the ATC with data link.
- The airline must be able to sustain CPDLC with the appropriate ATC, and data link AOC with its operations center.
- The ATC centers providing the control of the FIR where the re-routing will be done must have CPDLC capability.

2- PACOTS / DARP Track designations

PACOTS tracks still exist but many operators use them as UPR. Therefore, there are aircraft both on PACOTS and UPR (User Preferred Route). Consequently, no more strategic separations (50Nm) between aircraft can be applied.

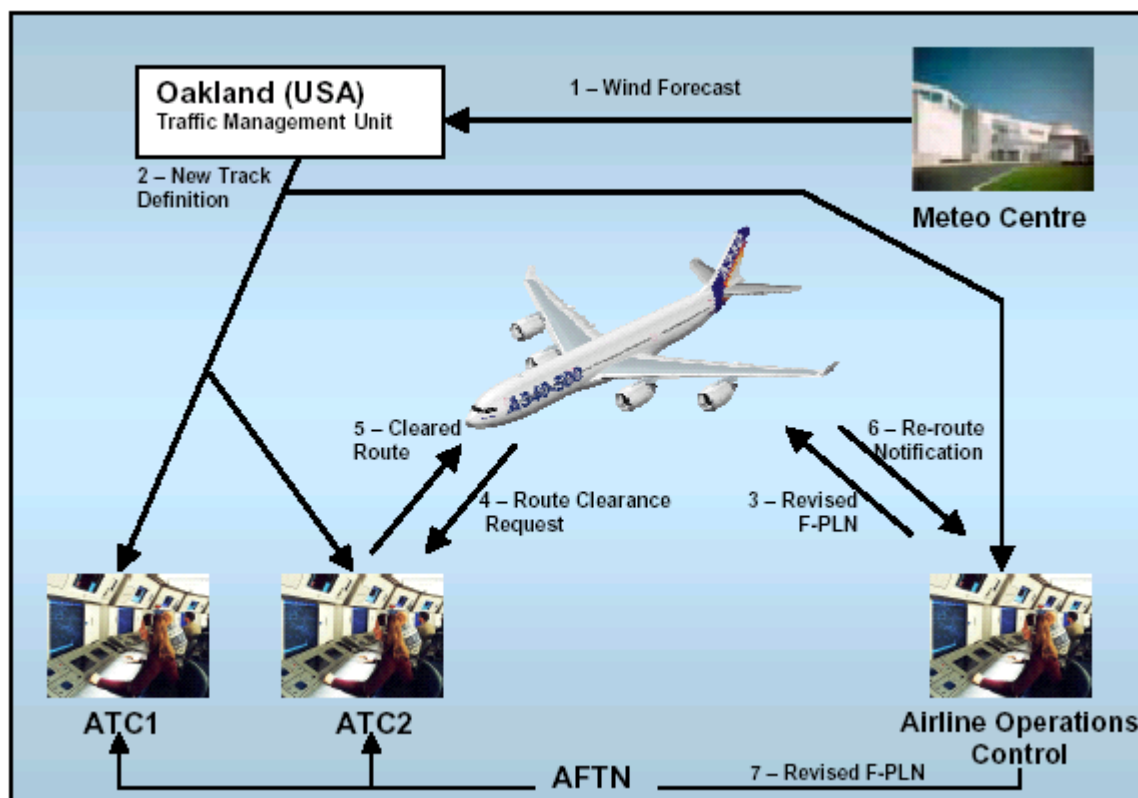
3- Descriptive drawing

The following sequence is applied:

OAKLAND

- Oakland (ZOA) receives new weather forecast and loads it in its system
- ZOA Traffic Management Unit defines the DARP entry point on the original track, at least 90 minutes ahead of the aircraft.
- ZOA TMU (Traffic Management Unit) defines a new track based on the old route until the DARP entry point.
- ZOA TMU sends a new TDM (Track Definition Message) to all concerned ATCs AOC / Aircraft/ ATC
- Following the receipt of the new TDM, AOC decides whether or not to re-route
- If re-route decided, the AOC uplinks the new route to the aircraft
- After evaluation of the received F-PLN, the pilot asks for a re-route clearance
- Once cleared, the crew activates the re-route and notifies it to his AOC
- The AOC transmits a Change message to the all concerned ATC (until AIDC exists)

The following drawing gives a general view of all the coordinated sequences that occur in a DARP phase.



Although promising this procedure has not been used very much for the time being, because it happens that the current wind models, as used by the airlines, are precise enough within the frame of the flight. Activating the DARP procedure requires a good co-ordination between all involved actors (Aircraft, AOC, ATC). The User Preferred Route procedure (UPR) is by far preferred by the airlines.

UPR (User Preferred Route):

The wind models used by the airlines are not the same than those used by the ATC when the daily PACOTS routes are defined. Differences of up to around 15 minutes of flight time are claimed by the operators. These have been asking for the possibility to define their own routes according to the daily conditions. They file their UPR Flight Plan. These UPR procedures are currently used between Los Angeles and both Sydney and Auckland.

Next Step: DARP from UPR

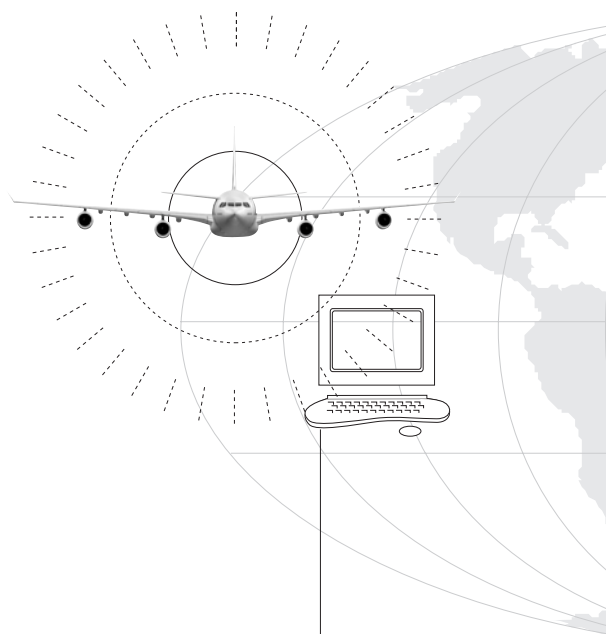
The South Pacific FIT is developing procedures for a trial of a DARP from the airlines' individual UPR. In this case, the airlines do not need to take into account the daily published PACOTS.

APPENDIX J

Airbus' AIRMAN Software description

As explain in part 4.3.2.3, Airbus offers its customers a tool called Airman in order to optimize the treatment of unscheduled maintenance events.

AIRMAN receives and analyses the aircraft status information generated by the On-board Maintenance System and automatically transmitted to the ground by the aircraft's communication system (ACARS for the time being).



AIRMANTM

simplifying and optimising
aircraft maintenance

Customer Services



AIRBUS



AIRMAN

AIRMAN's data analysis, synthesis and presentation provides:

- simpler, more effective troubleshooting,
- preventive maintenance recommendations,
- more effective engineering support.

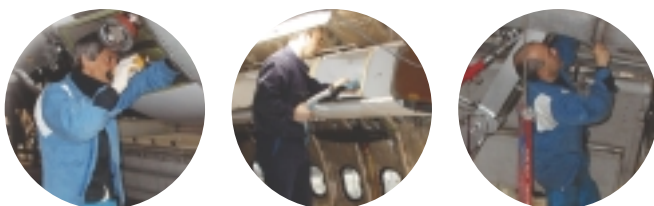
The result is:

1. improved aircraft Dispatch Reliability,
2. reduced operational costs,
3. reduced maintenance costs.



AIRMAN (version 2002)

General presentation



In order to optimise the treatment of unscheduled maintenance events AIRBUS offers their Customers a new tool. The tool is called AIRMAN. It is ground based software dedicated to the identification and management of unscheduled maintenance.

AIRMAN receives and analyses the aircraft status information generated by the On-board Maintenance System. The information is automatically transmitted to the ground by the aircraft's communication system. Logbook and maintenance action reports are also handled by this tool. These information sources are synthesised, combined with AIRBUS' and the Airline's own technical documentation and presented through a user-friendly interface.

Aircraft status information is sent to AIRMAN while the aircraft is both in-flight and on-ground. Message analysis also takes place in real-time. These capabilities maximise the time available for appropriate maintenance actions to be determined and preparations to be made.

AIRMAN is capable of analysing an aircraft's fault history and consequently identifying and prioritising preventive maintenance actions. This feature is designed to minimise Pilot reports and consequently departure delays.

Functions

The AIRMAN tool serves three principle areas of activity within the airline:

- **Gate Maintenance (fault identification and management)**
- **Hangar Maintenance (preventative maintenance identification and prioritisation)**
- **Engineering Services (line and hangar maintenance support).**

For further details see sheets F1, F2 and F3.

Capabilities

To support these functions AIRMAN has a wide variety of powerful capabilities:

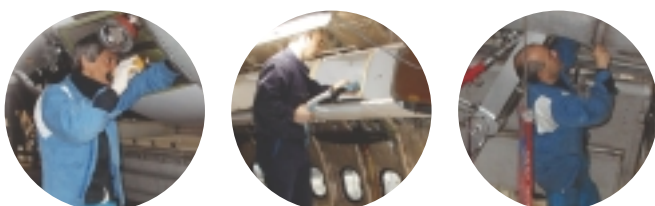
- **Real-time aircraft data capture and analysis**
- **Logbook and Maintenance Report acquisition**
- **Experience recording and replay**
- **Links to AIRBUS technical data viewers**
- **Standard interface to allow integration with Airline's IT system**
- **Customisation and Revision.**

For further details see sheet F4.



AIRMAN (version 2002)

Gate Maintenance (Fault identification and management)



Whether the aircraft is at the gate, on the runway or in-flight AIRMAN gives the user direct access to:

- an overview of the fleet's operational and technical status,
- logbook data, either transmitted by a compatible electronic logbook, or manually entered by the user (following a pilot call while the aircraft is in-flight or from the paper logbook when the aircraft is on the ground)
- On-board Maintenance System information automatically transmitted from the aircraft.
- technical documents from both AIRBUS and the Airline.



Figure 1: Fleet Status in real time



Figure 2: Log Book Entries

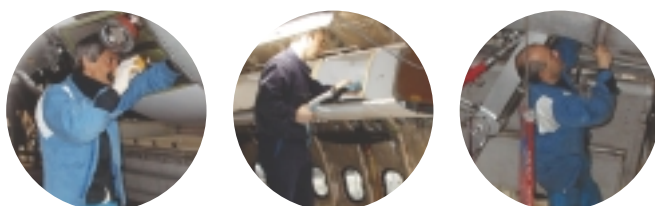
AIRMAN provides a centralised synthesis of all available information* related to any aircraft fault including previous occurrences of that fault (see figure 3: Maintenance Advisor). Analysis of the fault will automatically identify the most appropriate trouble shooting procedure. This ensures that the correct maintenance action is taken with the minimum of delay.

* documentation sources are described on sheet F4 – Capabilities.



Figure 3: Maintenance Advisor

(Preventative maintenance identification and prioritisation)



Once again the user has access to a centralised synthesis of all available information and is provided with the trouble shooting procedure most appropriate for identifying the source of the fault.

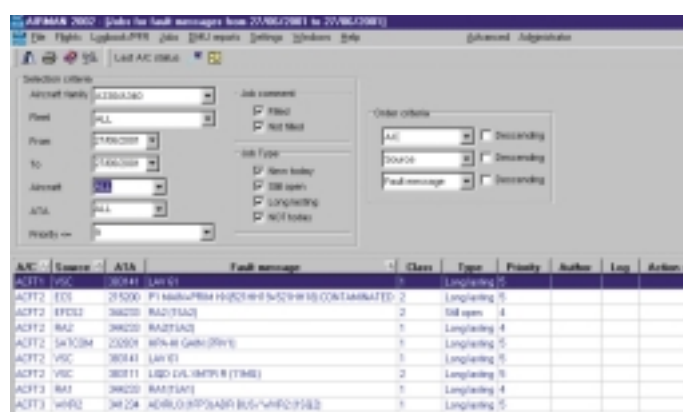
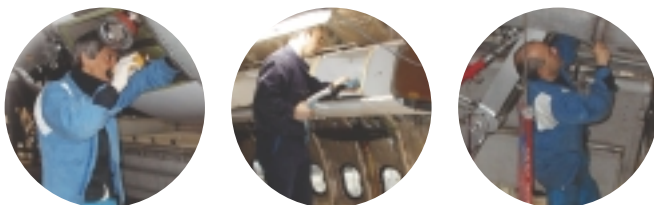


Figure 4: Jobs list

AIRMAN (version 2002)

Engineering Services

(Line and hangar maintenance support)



AIRMAN offers several functions that allow detailed investigations in to unscheduled maintenance issues.

For complex trouble-shooting users can access reports that list all recorded occurrences of a specific fault. These lists provide rapid access to all the information stored on those flights during which the specified fault occurred (i.e. pilot and maintenance logbook entries, On-board Maintenance System reports and previously deferred defects).

AIRMAN automatically provides a highly consistent report functions that allows users to monitor the:

- evolution of fleet technical status in terms of outstanding maintenance actions,
- fault occurrence rates for any or all systems on any or all aircraft,

Data Management Reports can now be accessed directly from AIRMAN to allow APU and Environmental Control System specialists to monitor the status of these systems.

All AIRBUS equipment suppliers have agreed to accept AIRMAN records as justification for removals. This allows systematic approach to No-Fault-Found cost reduction to be adopted.

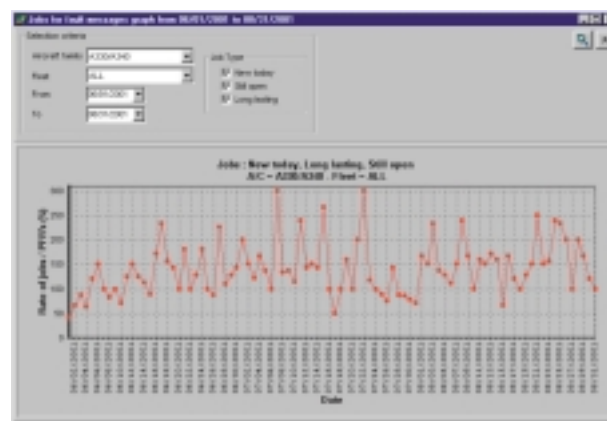


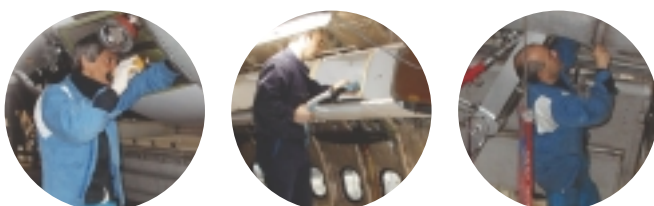
Figure 5: Outstanding Maintenance Trend

Figure 6: Fault History List



AIRMAN (version 2002)

Capabilities



Real-time aircraft data capture and analysis

Reports on aircraft status from the On-board Maintenance System are automatically sent to AIRMAN via the aircraft's communication system. These reports cover fault and operational information plus certain Data Management Unit reports. AIRMAN employs sophisticated algorithms to ensure that virtually all transmission errors are recovered.

Figure 7: Pilot Defect Report

Logbook and Maintenance Report acquisition

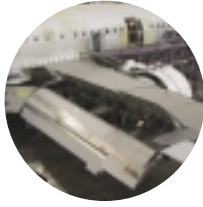
AIRMAN offers several mechanisms for the acquisition of technical logbook data:

- via the Airlines existing systems,
- direct manual entry using special assistants developed to reduce the time taken to enter the data and minimise errors,
- automatic transfer via AIRBUS' e-logbook (when available) which uses the data entry assistants found in AIRMAN.

Figure 8: Maintenance Report

PTO →





Experience Recording and Replay

Airline personnel can rapidly access all records of a specific fault on a specific aircraft or on the entire fleet. Each record contains all the available information for the flight during which the specified fault occurred (including deferred defects).

Links to AIRBUS technical data

The basic AIRMAN package includes access to the TSM, SILs and TFUs. The range of documents can be extended by using complimentary AIRBUS document reader tools.

Access to the AMM, IPC, TSM, ASM, AWM and ESPM is possible by the integration of AIRBUS' new document reader, AIRN@V. Access to the Airline's MEL is available through integration with AIRBUS' MMEL Starter Pack package.

Standard interface to allow integration with Airline's IT system

An industry standard data exchange interface has been developed that allows data to be quickly and easily transferred between AIRMAN and other IT systems.

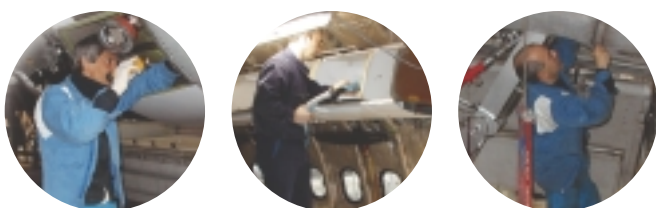
Customisation and Revision

In order to facilitate the integration of AIRMAN in to the Airlines existing processes and procedures it is possible to create and define several user profiles. In this way the access rights of each group of users can be precisely controlled.

The annual AIRMAN licence fee includes a revision service. Four times a year updates to AIRMAN's basic data sources are supplied in an easy to install package.

AIRMAN

Savings



After two years of operating with the year 2000 release of AIRMAN our customers have confirmed the following principle benefits:

Gate Maintenance function

- Direct access to TSM, SILs, TFUs and Airline's Technical Notes.
- Maximum amount of time for maintenance actions to be determined and prepared.
- Easy and rapid access to data relating to previous occurrences of a fault.

Predictive maintenance

- Identification and prioritisation of preventative maintenance tasks.
- Reduction in number and length of aircraft delays.
- Reduction in number of Pilot defect reports.
- Reduced line maintenance workload.

NFF cost reduction

- Provision of substantiated component removal (vendors provided with electronic record related to a specific removal).

As a result AIRMAN offers savings of several Dollars per flight hour. Customised business cases can be provided on request.

The 2002 release of AIRMAN presented in this document provides even greater opportunities for savings.

