Roadmap for the implementation of data link services in European Air Traffic Management (ATM):

Non-ATS applications

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Author	Helios Technology, Sofreavia, IATA, Integra Consult, Airbus
Produced by	Helios Technology Ltd Chamberlain House High Street Bagshot Surrey GU19 5AE Tel: +44 1276 452 811 Fax: +44 1276 472 897
Produced for	European Commission Directorate-General Energy and Transport
Helios contact	Mike Shorthose Tel: +44 1276 452 811 Fax: +44 1276 472 897 Email: mike.shorthose@helios-tech.co.uk
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AUTHORITY	NAME AND SIGNATURE	DATE
Helios Project Manager	Mike Shorthose	
Integra Project Manager	Dorte Wang	
IATA Project Manager	Nicolas Zveguintzoff	
Sofréavia Project Manager	Nga Bui	
Airbus Project Manager	Thomas Fixy	

Document Control

The following table records the complete history of the successive editions of the present document.

EDITION	DATE	REASONS FOR CHANGE	SECTIONS AFFECTED
0.1	25 May 2002	Initial draft for comment	All
1.A	25 Feb 2003	Updated to refect stakeholder comments	All
1.0	28 February 2003	FINAL VERSION	All

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1 Introduction

1.1 Contractual Matters

1.1.1 This document has been produced as part of a project for the European Commission to develop a Datalink Roadmap.

1.1.2 The work has been carried out under contract B2001/B2 – 7020B/S12.330694.

1.2 Purpose

1.2.1 This document provides a review on non-ATS applications requiring air-ground datalinks. The purpose is to determine the impact of these applications on technology choice within the Datalink Raodmap.

1.2.2 Applications are considered under the following headings:

- Airline Operational Control (AOC): services involving data transfer between the aircraft and the Airline Operational Centre or operational staff at the airport associated with the safety and regularity of flights. The Airline Communications Addressing and Reporting System (ACARS) has supported this service since the 1980s. 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.
- Airline Administrative Communications (AAC): includes 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 on the safety and regularity of flight. AAC applications are not specified by ICAO and should not use communications resources reserved for safety communications.
- 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.

1.3 References

1.3.1 A master reference list for the Datalink Roadmap project is provided in P167D3030.

1.4 Document Structure

1.4.1 The remainder of this document consists of the following sections:

- Section 2: Aeronuatical Ooperational Communications
- Section 3: Airline Administrative Correspondence
- Section 4: Airline Passenger Communications
- Section 5: Conclusions

2 Airline Operational Communications

2.1 Inroduction

2.1.1 Aeronautical Operational Communications (AOC) services are concerned with the safety and regularity of flight and as such are defined in Annex 6 of the ICAO Convention. AOC applications involve data transfer between the aircraft and the Airline Operational Centre or operational staff at the airport.

2.1.2 AOC Applications have been supported by the ACARS (Aircraft Communications Addressing and Reporting System) system since the 1960s. ACARS is a character oriented system which was initially deployed on a VHF analogue data link (AVPAC) but can now be operated over VDL Mode 2, HFDL and AMSS Datalink.

2.1.3 An excellent overview of the current use of ACARS is provided at the SAS technical web-site.

2.1.4 AOC is considered a high growth area. The Airlines are able to use datalink applications to support operational optimisation and in some cases such as engine monitoring leading to lower insurance premiums.

2.1.5 As the role of AOC applications continues to grow, two particular forms lead to the highest communication loads:

- Communications at the Gate: Significant information exchange occurs between the airline operational staff and the aircraft when the aircraft is parked at the airport. This communication covers such things as Log Book transfers and even uplink of software updates. These applications require high bandwidth and integrity, but are not time critical.
- Airborne Monitoring Applications: A number of recent AOC applications have supported real time monitoring of aircraft performance during flight. This is likely to be a growing trend. Research is also considering the possibility of providing telemetry data via datalink to support accident investigation. Given the recent terrorist acts in the US, additional requirements such as downlinking live video/audio from the cockpit are also under consideration.

2.2 Current Applications

2.2.1 Current AOC Applications include:

- Out Off On In (OOOI)
- NOTAM Request/NOTAMS
- Free Text
- Weather Request/Weather
- Position Weather Report
- Flight Status
- Fuel Status
- Engine Performance Reports

- Maintenance Items
- Flight Plan Request/Flight Plan Data
- Loadsheet Request/LoadSheet
- Flight Log Transfer

2.3 Future Applications

2.3.1 The following additional AOC services are considered likely in the timeframe 2005-2010.

- Real Time Maintenance Information
- Graphical Weather Information
- Online Technical Trouble Shooting
- Real Time Weather Reports for Met Office
- Telemedicine
- Technical Log Book Update
- Cabin Log Book Transfer
- Onboard Documentation Transfer
- Software Loading

2.3.2 AOC is seen as a strong growth area. Information exchange is seen as a way of improving airline efficiency. Particular growth areas could be:

- Collaborative Decision Making
- Gatelink Applications
- Security Monitoring: There are a number of proposals to downlink both audio and video recordings during a flight.

2.4 Technical Requirements

2.4.1 ACARS applications are designed to be supported on character-oriented VHF datalink, which offers low QoS – it is estimated that 6% of ACARS messages are lost during transmit. The following table contains typical QoS parameters for ACARS applications.

Parameter	Value
Access Delay	N/A
Transit Delay	90 seconds
Availability	94%
Accuracy	10^{-6}

Table 1 AOC Application QoS

2.4.2 The following table summarises the throughput requirements for these applications.

Application	Message Size (octets)	Frequency	Total Per Flight (octets)
Current Applications			
Out Off On In (OOOI)	40	4 per flight	160
NOTAM Request/NOTAMS	102 / 276	2 per flight	756
Free Text	296	1 per flight	296
Weather Request/Weather	80	2 per flight	160
Position Weather Report	261	1 per flight	261
Loadsheet Request/LoadSheet	80	1 per flight	80
Flight Status	80	Every 15 min	960
Fuel Status	40	2 per flight	80
Engine Performance Reports	100	3 per flight	300
Maintenance Items	100	1 per flight	100
Flight Plan Transfer	200	2 per flight	400
Load Sheet transfer (gate)	80	1 per flight	80
Flight Log Transfer (gate)	100	2 per flight	200
Total Per Flight			3629
Near Future Applications			
Real Time Maintenance Information	50	5	250
Graphical Weather Information	2000	4	8000
Online Technical Trouble Shooting	500	5	2500
Real Time Weather Reports for Met Office	26	180	4680
Telemedicine	4000	8	3200
Technical Log Book Update (gate)	400	1	400
Cabin Log Book Transfer (gate)	400	1	400
Onboard Documentation Transfer (gate)	1000	1	1000
Software Loading (gate)	4000	2	8000
		Total Per Flight (Airborne)	18630
		Total Per Flight (Gate)	9800
Future Applications (2005+)			
Collaborative Decision Making	5000	1	5000
Gatelink Applications (gate)	50,000	1	50000
Security Monitoring	128	Every sec	921,600
		Total Per Flight (Airborne)	18630
		Total Per Flight (Gate)	9800

Table 2 AOC Throuhput Requirements

2.5 Technology Options

2.5.1 The bandwidth requirements show a potential massive increase for both airborne and gate communications. New technologies will be required to support this growth.

3 Airline Administrative Communications

3.1 Introduction

3.1.1 Airline Administrative Communication (AAC) is the non-regularity of flight counterpart of AOC. The applications are concerned with other elements of the airlines business such as crew rostering and cabin provisioning. These are essential to the airlines business, but do not impact on the safety and regularity of flight. AAC applications are not specified by ICAO, and should not use communications resources reserved for safety communications.

3.1.2 Currently, very few applications are classified as AAC. There is strong potential for growth in this area, in particular in terms of communication at the Gate.

3.2 Current Applications

3.2.1 The Airline Administrative Communications category includes applications that support the airlines business, but have no impact on the safety or regularity of flight. An example would be the pilot informing the destination airports of any problems the passengers may have in disembarking. This allows the airline to provide the requisite number of wheelchairs at the gate.

3.2.2 AAC applications are often of this nature and are supported by Free Text messages. The Quality Service parameters are the same as for AOC, but clearly these could be relaxed.

3.3 Future Applications

3.3.1 Potential future applications include:

- Passenger Lists
- Aircraft Catering
- Baggage Handling
- Lost and Found
- In-flight Assistance
- Duty Free Sales
- Passenger Surveys

3.4 Technical Requirements

3.4.1 As service provision has no impact on flight safety, quality of service requirements are generally lower than for ATC and AOC applications. The following tables summarises anticipated throughput for the applications.

Application	Message Size (octets)	Messages per flight	Total per flight (octets)
Current Applications			
Crew and Aircraft Schedule	100	1	100
Quality Monitoring	50	2	100
Service messages	100	4	400
		Total Per Flight	600
Future Applications			
Passenger Lists	10,000	2	20,000
Aircraft Catering	10,000	2	20,000
Baggage Handling	10,000	2	20,000
Lost and Found	10,000	2	20,000
In-flight Assistance	10,000	2	20,000
Duty Free Sales	10,000	2	20,000
Passenger Surveys	10,000	1	10,000
		Total Per Flight	136,000

Table 3 AAC Throughput Requirements

3.4.2 Notes that the potential increase between current and future applications.

3.5 Techhnology Options

3.5.1 Current AAC applications are supported by the ACARS network using VHF, HF and AMSS Datalinks. These datalinks will not support the potential increase in the bandwidth for these applications.

4 Airline Passenger Correspondence

4.1 Introduction

4.1.1 This category of applications includes communications services that are offered to passengers either within the ticket price or as a chargeable service.

4.2 Current Applications

4.2.1 Current applications offered to the passenger include:

- Email;
- Internet access;
- Live TV (news and sport);
- Telephony (voice, fax and data);
- Value added services (hotel reservations, car hire etc).

4.2.2 In general, it is assumed that email, internet access and telephony would be chargeable services. Live TV would be included in the ticket price.

4.2.3 In the case of web browsing, one approach is to store the most frequently accessed web pages on an aircraft server thereby reducing the communications requirements significantly. For the purposes of this study it is assumed that this approach would not be acceptable to the majority of users and full internet access is required.

4.3 Future Applications

4.3.1 No additional applications are foreseen, however there is considerable interest in developing APC services at present and a number of organisations representing the complete supply chain are active in developing services and demonstrating systems.

4.4 Technical Requirements

4.4.1 As service provision has no impact on flight safety, quality of service requirements are generally lower than for ATC and AOC applications. However, sevrive provision does need to be sufficient to maintain customer base. The challenge for APC is to deliver the service economically.

4.4.2 The traffic volumes generated by such services are inherently less predictable than air traffic control applications and will be dependent upon pricing policy and rate of aircraft equipage.

4.4.3 In order to determine traffic levels, the following assumptions are made:

- Initially, only long haul air transport and business jets are equipped;
- Long haul aircraft capacity is 300 passengers;
- Business jets typically contain 8 workstations;
- An average flight duration is 8 hours of which half may be used to access communications services;

- For air transport, 25% of passengers are business class and 75% are economy class;
- 50% of business passengers and 10% of economy passengers make use of communications services;
- Email and internet usage profiles are similar to terrestrial business users;
- Telephony usage profiles are similar to business mobile telephone users;
- All workstations on business jets are used.

4.4.4 The following table provides indicative usage profiles for email, internet and mobile telephony for typical business users.

Email[1]	Mean number of messages per flight	10 (sent) 12 (received)
	Mean message size	80K octets
Internet	Mean time connected per flight	30 minutes[2]
	Mean bit rate per user[1]	200 bits per second (transmitted) 1000 bits per second (received)
Telephony[1]	Mean number of calls per flight	3
	Mean call duration	2 minutes

[1] Measured utilisation levels of terrestrial services for typical business users.

[2] Sevcik, P J, "The Myth of Internet Growth", Business Communications Review, January 1999. Assumes one session of internet use/user/flight.

Table 4 APC Aplication Usage

4.4.5 Based upon the traffic profiles in Table 24 and the assumptions provided above results in the following traffic volumes per flight for APC applications:

Application	**Data volume per flight**	
	Downlink	Uplink
Air transport		
Email	52 Mbytes	62 Mbytes
Internet	3 Mbytes	15 Mbytes
Telephony	10 hours total call volume	
Business jets		
Email	6 Mbytes	8 Mbytes
Internet	0.5 Mbytes	2 Mbytes
Telephony	1 hour total call volume	

Table 5 APC Throughput Requirements

4.4.6 It should be noted that this table represents a possible profile. The actual traffic level will be subject to wide variation due to maturity of the market, promotion by airlines and service providers etc. It is based on business usage profiles and other internet users may generate different profiles (eg chat room users, on-line gamers).

4.4.7 However, it provides a measure of the order of traffic level for comparison with other applications. It will be very important to test the sensitivity of any business case to APC traffic levels.

4.4.8 For live TV, transponders will be required for each channel/region where services are offered. It is assumed that sufficient capacity is available to meet the demand for TV broadcasts to aircraft. Note that coverage is currently limited to the land masses.

4.5 Technolgy Options

4.5.1 Current APC services are offered via the INMARSAT AMSS service. It is anticipated that services will migrate to high bandwidth INMARSAT services (such as Aero-GAN) as these become available.

4.5.2 Live TV will make use of digital broadcast satellite channels (as used by terrestrial receivers). Transmissions will consist of news and sports. Content will be regionalised so that sporting events that are likely to be of interest are broadcast and programmes are transmitted in the relevant language.

5 Conclusions

5.1 This document has reviewed current and potential application in the following areas:

- Airline Operational Communications
- Airline Administrative Communications
- Airline Passenger Correspondence

5.2 All three areas have potential growth. The growth in AOC could support the changing ATM paradigms. AOC will require high bandwidth communications both whilst airborne and at the gate.

5.3 AAC and APC also display potential for increasing airline revenue.

5.4 The bandwidth requirements for APC in particular are massive when compared to predicted requirements for ATC applications.

5.5 This leads to the possibility of ATC applications sharing a high bandwidth media deployed for APC reasons. APC is only applicable to longhaul, premiun short haul and business aircraft. Low-cost operators are not interested in APC, or indeed broadband solutions.

5.6 The roadmap should consider:

- Support for AOC applications
- Sharing bandwidth, at least as a backup, with APC applications.