

ELEVENTH AIR NAVIGATION CONFERENCE**Montreal, 22 September to 3 October 2003****Agenda Item 7 Aeronautical air-ground and air-to-air
: communications****CURRENT TRENDS IN THE IMPLEMENTATION OF AIR TRAFFIC
SERVICE DATA LINK APPLICATIONS**

(Presented by the Airline Telecommunications and Information Services (SITA))

SUMMARY

This information paper provides an overview of the current status of the air traffic use of data link and the benefits that increasing numbers of air traffic service providers are obtaining by leveraging the use of existing avionics data link capabilities in commercial aircraft. The paper provides the necessary background information to the companion SITA "Action Paper" (AN-Conf/11-WP-159) which seeks the conference's endorsement that the expanded use of installed data link avionics be encouraged as a means to realise near term and sustainable benefits, ultimately for the benefit of the travelling public.

REFERENCES

1. Aircraft communications link selection, SITA, August 2003
2. Air traffic services data link implementation status, SITA, August 2003
3. AIRCOM transition from ACARS to ATN, SITA, August 2003

1. INTRODUCTION

1.1 The Airline Telecommunications and Information Services (SITA), as the airline owned and controlled organisation providing global air-ground and ground-ground data communications services to the majority of the world's airlines and increasing numbers of air traffic service providers, is pleased to report on current trends in the implementation of air traffic service data link applications. These trends suggest a way forward to optimize the considerable investments required both of airlines and air traffic service providers for the ultimate benefit of the travelling public.

1.2 This paper provides the necessary background to an accompanying SITA working paper, by reporting on the current trends of air traffic service data link implementation. The paper also provides an overview of near term benefits that increasing numbers of air traffic service providers are obtaining by leveraging the use of existing aircraft communications addressing and reporting system (ACARS) data link avionics in commercial aircraft via networks such as the SITA AIRCOM data link service, and of SITA's progress in implementing the ground stations that provide the ICAO Standard compliant VDL Mode 2 service.

2. FANS-1/A DATA LINK

2.1 The primary objective of FANS 1/A applications (i.e. automatic dependant surveillance-contract (ADS-C) and controller pilot data link communications (CPDLC)), that use the ACARS data link, is to provide operational benefits in remote and oceanic airspace, for example by enabling aircraft to fly more economical routes with increased payload, resulting in either cost savings and/or increased revenue.

2.2 Since the FANS 1/A enabled services were initially introduced in the South Pacific region in 1995, their usage has generated increasing benefits as the region's air traffic service providers and participating airlines have gained greater experience with the technology.

2.3 Noting these benefits, coupled with the increasing number of FANS 1/A equipped aircraft operating in their airspace, air traffic service providers in other regions have also introduced the necessary ground processing and are currently appraising and exploiting the benefits of this technology by varying degrees. These States include:

- a) Pacific: Australia, Airways New Zealand, France (Tahiti), Fiji, Japan and the United States;
- b) South East Asia: Singapore, Myanmar, Philippines, Indonesia, and Malaysia;
- c) Asia: India, Mongolia, Sri Lanka, China and Hong Kong;
- d) Africa: South Africa, Mauritius, Madagascar, Cape Verde;
- e) Middle East: Egypt and Iran;
- f) Europe: Russia, Benelux/Germany (Eurocontrol Maastricht UACC);
- g) North Atlantic: Canada, United Kingdom, Iceland, Portugal, United States;
- h) South Atlantic: Spain, Cape Verde, Brazil;

2.4 FANS 1/A based services offer greatest potential benefits in oceanic and remote terrestrial airspace where the CNS infrastructure is limited or reliant on procedural HF voice reporting. Therefore the types of aircraft equipped with the FANS 1/A package are typically long haul aircraft (e.g. Boeing 747-400, AIRBUS 340/330) that operate in such environments.

2.5 However, it is significant to note that the Eurocontrol Upper Area Control Centre (UACC) at Maastricht, which provides air traffic services in some of the most dense airspace in the world, is now providing operational FANS 1/A enabled CPDLC services and associated benefits to increasing numbers of participating airlines. The Maastricht FANS 1/A service follows an extensive and successful trial (“PETAL”) that saw in excess of 10,000 flights log on to the service enabled by SITA AIRCOM in the period 1998 to 2002. Whilst issues have been raised with respect to the suitability of providing CPDLC services via FANS 1/A technology in such dense airspace, these will be mitigated by the operation of the application over a VDL Mode 2 subnetwork service and the planned evolution by Boeing and AIRBUS of the FANS 1/A package to what has become to be termed as “FANS 1/A+”.

2.6 According to industry estimates, there are currently 1,200+ FANS 1/A equipped aircraft in operation around the world today and this number is set to increase to 2,000 by the end of the decade.

2.7 While the FANS 1/A package was originally foreseen on dual aisle long-haul aircraft (i.e. A330/340), AIRBUS is planning to release a version of FANS for the single aisle A320 series due to requests from customer airlines operating such aircraft in the South Pacific region. This will undoubtedly result in an increase in the total numbers of FANS 1/A equipped aircraft and may further add to the business case for the further provision of FANS 1/A services in domestic airspace.

2.8 Since its introduction, FANS 1/A technology, which includes support for satellite navigation as well as data link, has enabled the following benefits:

Reduction in separation minima:

2.8.1 There are many remote areas in the world, where the minimum separation distances between aircraft on the same route are very high, for example 15 minutes (approximately equivalent to 120 NM). The number of aircraft flying on these routes is rising and this long separation is causing aircraft to not be able to access their optimal level due to traffic.

2.8.2 The use of FANS-1/A avionics is allowing ATS providers to reduce the minimum separation between aircraft (e.g. down to 30 NM) on these routes providing controllers with more flexibility to allow FANS 1/A equipped aircraft increased access to their optimal flight levels, thereby achieving greater fuel economy.

Dynamic routing:

2.8.3 The first air traffic services benefit from FANS-1 CPDLC is called “Dynamic Airborne Route Planning” (DARP) in which daily revised routes are used by all DARP aircraft between those city pairs. The original DARP procedure allowed an aircraft while airborne to re-route from the originally filed route to an even more economical route, by taking advantage of the latest wind forecast. In the South Pacific, DARP has since been replaced with user preferred routes (UPR) that are generated by each airline and optimised for their particular aircraft. Between a given city pair there can now be a UPR for each airline’s aircraft rather than one DARP for all airlines.

Reduction in communications costs:

2.8.4 The North Atlantic region has been using the FANS-1/A application to enable the reporting of waypoint position reports (WPR) via data link in place of HF voice radio. Results to date trials have shown that 85% of the pilot/controllers R/T workload can be reduced by the adoption of FANS technology for this specific purpose alone. As of mid 2003, approximately 33% of NAT traffic report waypoint position information was via FANS 1/A. As an incentive to take the pressure off the HF voice network, Canada has reduced its communications charges to aircraft using waypoint position reporting via FANS 1/A. Without FANS in the NAT the supporting HF infrastructure would be seriously overloaded today.

2.8.5 From an efficiency perspective, the NAT WPR service has demonstrated the 95 percentile delivery time for WPRs using Satellite and VHF via FANS data link is 2 minutes, compared to the 9 minutes that HF voice reporting currently takes.

2.8.6 In addition to FANS 1/A, flight management computer (FMC) waypoint position reporting will be facilitated by SITA in the NAT by the end of 2003 and is forecast to increase the numbers of NAT aircraft reporting their position via data link to 41%.

3. AIR TRAFFIC SERVICES USE OF ACARS

3.1 By the early 1990's most of the world's airlines had equipped their fleets with ACARS data link avionics for aeronautical operational control (AOC) messaging between aircraft and their airline host processing systems. In order to leverage this investment and gain early experience with air traffic services data link, a number of air traffic service providers introduced "initial" applications that would operate over the text-based ACARS data link service (also known as "Plain Old ACARS" (POA)).

3.2 These initial ATS data link applications use the basic ACARS data link to carry text messages. They do not require the aircraft automation implied by the ICAO Standard applications implemented in FANS or ATN avionics.

3.3 The ACARS avionics provide a basic capability for flight crew to input text and to display received text messages on a cockpit printer or screen. The type of ATS services most suitable for implementation using ACARS involve the transfer of large amounts of information that is not as time-sensitive as normal pilot-controller communications. Such applications are not time-sensitive as the transmission of the information by voice communications already takes a long time.

3.4 The initial data link applications that have been implemented include pre-departure clearance, departure clearance, digital-ATIS and ocean clearances services. Based on the experiences and benefits generated through the deployment of these applications since the early 1990's, increasing numbers of air traffic service providers have since deployed and/or plan to deploy these services over the coming years including:

- a) Asia/Pacific: Australia, Japan, Korea, New Zealand, Singapore, Taiwan, China (Hong Kong);
- b) Africa: Ivory Coast, South Africa;

- c) Middle East: Bahrain, United Arab Emirates (Dubai);
- d) Europe: Austria, Belgium, Denmark, France, Germany, Ireland, Norway, Spain, Portugal, Sweden, Switzerland, United Kingdom;
- e) North Atlantic: United Kingdom, Canada; and
- f) North America: Canada, United States.

3.5 Some States are investigating the possibility of further exploiting the use of ACARS technology. For example, the United Kingdom is looking at the viability of delivery of HF frequencies by data link to oceanic West-bound aircraft, and the delivery of routes and re-route clearances and SSR codes to East-bound aircraft on entry to domestic airspace.

4. SITA AIRCOM DATALINK SERVICE

4.1 SITA launched the VHF AIRCOM service in Australia in around 1985 when aircraft were first equipped with cockpit data communications systems called ACARS avionics. Since that time, the VHF AIRCOM coverage has expanded to provide almost global coverage with around 700 VHF stations deployed in over 170 countries around the world. The ACARS service uses the VHF band assigned to airline communications. Obtaining the ground station licences was simplified by SITA being an airline owned organisation.

4.2 SITA launched the Satellite AIRCOM Data Link service in the early 1990's. Today, this service is being used by over 1,500 aircraft that generate an average of 50,000 kilobits of traffic on a daily basis. The satellite service provides global coverage (except polar regions) via the use of the 4 INMARSAT geo-stationary satellites, accessed via Ground Earth Stations in France and Australia. The service is currently used in ACARS mode (i.e. DATA 2) but has been capable of providing ICAO AMSS compliant (i.e. DATA 3) services since it's launch.

4.3 The VHF AIRCOM service makes efficient use of the limited number of assigned frequencies as demonstrated in Western Europe where a single 25 KHz base frequency channel complemented by two additional frequencies, (terminal and en-route), carries all traffic where the usage is at its greatest.

4.4 The SITA VHF AIRCOM Data Link service is used by over 5,000 aircraft on a daily basis exchanging over 400,000 kilobits of traffic, 95% of which are aeronautical operational control (AOC) and the remaining 5% air traffic service communications.

4.5 The SITA VHF and satellite AIRCOM Services are compliant with the Standards established by the Airline Electronic Engineering Committee (AEEC) that primarily define the avionics interfaces to the communications system. The AIRCOM service has also evolved to comply with the applicable RTCA and EUROCAE Standards that define performance and certification standards.

4.6 The initial driver for the deployment of the VHF ACARS service was the "Out, Off, On, In" (OOOI) AOC application that is today implemented by all ACARS users. The majority of these airlines have

subsequently introduced increasingly sophisticated applications that enhance efficiency and safety of operations, for example engine exceedance monitoring, fuel information and take-off data calculations. The continued availability of the ACARS service is considered mission critical for the majority of airline users and, as a result, the AIRCOM Data Link Service is required to comply with stringent Service Level Agreements.

5. ICAO VDL STANDARDS

5.1 The ICAO initiative to develop standards for a VHF Digital Link was launched following an IATA recommendation, supported by SITA, to the tenth Air Navigation Conference in 1990. SITA participated in the specification of the initial VHF Digital Link Modes 1 and 2 and ensured the system would be able to replace the VHF ACARS system that uses analogue radios. The ICAO AMCP completed the VDL Mode 2 Standards in 1996 and since then Communications Service Providers have started the deployment of VDL Mode 2 services.

5.2 VDL Mode 2 avionics have been developed to support ATN communications but the enhanced bandwidth provided is also being used to provide improved performance for ACARS applications, which is accelerating the installation of VDL avionics in the aircraft fleet. The SITA deployment of VDL Mode 2 services started in 2001, today there are 25 sites with operational VDL Mode 2 service and this number will increase to over 40 sites by the end of 1st quarter 2004. All these ground stations provide VDL Mode 2 service on the same VHF frequency channel, because the system was designed to enable ground stations to re-use the same channel in overlapping coverage.

5.3 The ICAO AMCP also developed standards for a VDL Mode 3 supporting digitized voice as well as data link and a VDL Mode 4 supporting aircraft-to-aircraft data exchanges as well as air-ground exchanges.

5.4 The VDL Mode 3 system was proposed by the United States FAA to replace the VHF analogue voice system. VDL Mode 3 can provide multiple voice circuits per 25 kHz channel but it faces competition from VHF analogue voice using 8.33 kHz channel spacing, which is now supported by many aircraft radios. The VDL Mode 3 system requires ground stations to be assigned a VHF channel that is not reused by any other station covering the service volume. This means its introduction would require a complete reorganization of the band and is an order of magnitude more complicated than introducing VDL Mode 2. The digitized voice service that VDL Mode 3 could provide could also be obtained from planned future aircraft satellite communication systems and it is essential for the industry to evaluate if the next generation of cockpit voice service should use the VHF radio-communications band.

5.5 The VDL Mode 4 system was proposed by the Swedish CAA as a means to support ADS-Broadcast, along with other applications. However, ADS-B is now being implemented using the Mode S extended squitter in the air transport aircraft that are likely to be equipped with VDL Mode 2 to support CPDLC and ACARS. There are also frequency management issues with VDL Mode 4 causing co-site interference on aircraft with multiple VHF radios, and potential safety certification issues with real-time surveillance sharing a link with other applications. The industry decision to implement ADS-B using the Mode S extended squitter instead of VDL Mode 4 indicates that splitting up work on various data links between different ICAO panels can lead to wasting State and industry resources on specification of the technologies that may never be implemented.

5.6 Given the position of the majority of the airline community, and therefore SITA's customers, as presented by IATA (ANC-Conf/11-WP/54) on VDL Mode 3 and VDL Mode 4 implementation in avionics, SITA does not plan to deploy services implementing VDL Modes 3 and 4 in the foreseeable future.

6. AERONAUTICAL TELECOMMUNICATION NETWORK

6.1 The ICAO ATN standard specifies the use in data networks of a "internet" protocol based on ISO Standards. This ATN internet protocol was expected to be used for ground-ground and air-ground communications but it has become clear that there is no need to use ATN internet routing between the AMHS messaging systems expected to replace AFTN switches. The ATN internet protocol will now probably only be used as a means to support air-ground data link applications and in particular CPDLC.

6.2 The ICAO ATN Internet protocol and routing protocols have not been used in any other industry so they are unique and relatively complex with the result that the development of the required avionics and supporting ground systems has proved to be a lengthy and expensive process. Initial CPDLC/ATN avionics have only just recently become commercially available and have enabled the launch of the first two operational implementation initiatives in the United States (CPDLC Build 1) and Europe (Link2000+). On the ground side, ATN Routers and ATN Host System products (i.e. "End Systems") are available from a limited number of suppliers that are finding it difficult to continue investing in the technology given the relatively slow take up by the ICAO States. As a result, these products are very expensive when compared to the commercially available TCP/IP peer products.

6.3 The reference in the ICAO ATN Standards to ISO Standards was intended to ensure that the aviation industry would benefit from using protocols widely implemented in other industries. The ATN Standard, however, maintains its references to these ISO protocols although they have been overtaken by the generic Internet protocol and never been implemented in other industries so the original objective has not been achieved. ICAO should consider in future specifying only performance requirements and avoiding detailed specifications of protocols that may become obsolete as the technology evolves.

7. AIR TRAFFIC SERVICE DATA LINK INTEROPERABILITY, SAFETY AND PERFORMANCE REQUIREMENTS

7.1 The ICAO standardisation process for data link systems has, to date, taken little or no account of certification requirements and operational approval criteria as they have been considered by ICAO to be issues for national regulators. However, the business case for implementation of new data link systems has to cover aircraft certification and operational approval as this can represent a major cost item. Account and assessment of these issues must be made prior and during the development of the ICAO technical standards in order to avoid wasting resources defining technologies that in the end may never be implemented due to certification constraints.

7.2 In order to facilitate the granting of aircraft certification and operational approval of the use of data link for air traffic service purposes, the European Organisation for Civil Aviation Equipment (EUROCAE) and the United States based Radio Technical Commission for Aeronautics (RTCA) have

developed a series of documents that provide guidance to national/regional regulators. These documents define and allocate the Interoperability, Safety and Performance requirements that each element of the end-to-end chain must satisfy. National Regulators may require compliance with these documents as one of their criteria for granting certification and operational approval.

7.3 Approval for ATS use of data link has often been delayed by being required to meet performance requirements that are much higher than the performance of the ATS system based on voice. To obtain benefits from data link as quickly as possible new systems should be required to improve on existing systems rather than provide the performance of a theoretical system whose implementation might not be economically justifiable.

8. CONCLUSIONS

8.1 Given the preceding sections, SITA draws the attention of the conference to the following set of conclusions that provide an input to the overall picture of the current trends in the global implementation of data link to support air traffic service applications:

- a) the population of aircraft equipped with ACARS avionics (approx. 10,000 today) and FANS 1/A avionics (approx. 1,200 long haul today) and will continue to increase;
- b) airframers are considering the introduction of FANS 1/A technology in single aisle aircraft which will further add to the population of FANS 1/A aircraft;
- c) an increasing number of air traffic service providers have since the early 1990's/or shortly plan to introduce air traffic service data link applications (ADS, CPDLC, Digital-ATIS, Departure Clearance and Oceanic Clearance) to suitably equipped aircraft and, in many cases, are providing clear operational benefits to air traffic service providers and airlines alike;
- d) operational FANS 1/A CPDLC services have been introduced by Eurocontrol in Maastricht airspace which ranks amongst the densest in the world;
- e) the North Atlantic region plans to introduce Flight Management Computer Waypoint Position Reporting that will provide further operational benefits to the FANS 1/A ADS Waypoint Position Reporting service that is operational today;
- f) the SITA AIRCOM Data Link service is used by over 5,000 aircraft on a daily basis exchanging over 500,000 messages; Approximately 95% of these messages are AOC and 5% ATS communications;
- g) the SITA ACARS and FANS communications service has supported the pioneering introduction of these initial air traffic service applications and has continued to evolve to meet the emerging air traffic service performance requirements;
- h) VDL Mode 2 has been standardised by ICAO to enable the exchange of both Air Traffic Service and Aeronautical Operational Control communications, initially using a

single 25 MHz frequency channel that will be shared by the communications service providers and is therefore very efficient in its use of spectrum;

- i) VDL Mode 2 services enable data throughput rates per aircraft in the range of 12-13 kilobits/second as compared to the 300 bits/second performance provided by ACARS today;
- j) VDL Mode 2 has been accepted by the industry as the natural evolutionary replacement for ACARS as demonstrated by the commercial availability of VDL Mode 2 avionics, major airline plans to equip entire fleets with VDL Mode 2;
- k) VDL Mode 2 services are available today in Western Europe, Singapore, United States, Australia, Japan and will shortly be introduced in Spain and Brazil;
- l) VDL Mode 2 has been adopted by the United States (FAA CPDLC Build 1 Programme) and Europe (Link2000+ Programme) as the underlying subnetwork technology for the exchange of ICAO compliant CPDLC services over an ATN infrastructure;
- m) VDL Modes 3 and 4 will need to overcome significant challenges to implement for the reasons outlined in paragraphs 5.4, 5.5 and 5.6; the most significant of which is the IATA position which represents the majority of the world's airlines;
- n) when standardising future data link technology, ICAO needs to take into account a number of issues including the overall business case, the technical feasibility of developing and integrating such avionics in commercial aircraft and ensuring that the appropriate frequency channel assignments can be made available;
- o) with respect to the approval of data link for ATS, the performance of the data links should be evaluated against their improvement over existing systems (e.g. VHF R/T) rather than comparing the existing data links with potential future links that may never be implemented; and
- p) the standardisation process of ICAO data link technologies needs to take into account the certification and operational issues that will be faced when the technology is eventually implemented.

— END —