ELEVENTH AIR NAVIGATION CONFERENCE

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AN OVERVIEW OF AERONAUTICAL FIXED SERVICE (AFS) DEVELOPMENTS

(Presented by the Secretariat)

SUMMARY

This information paper provides an overview of global and regional developments in the implementation and evolution of the aeronautical fixed service (AFS).

1. BACKGROUND

1.1 Aeronautical fixed service (AFS) has been defined in Annex 10, Volume II, as shown below:

> 4.1.1 The aeronautical fixed service shall comprise the following systems and applications that are used for ground-ground (i.e. point-to-point and/or point-to-multipoint) communications in the international aeronautical telecommunication service:
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> a) ATS direct speech circuits and networks;
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> b) meteorological operational circuits, networks and broadcast systems;
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> c) the aeronautical fixed telecommunication network (AFTN);
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> d) the common ICAO data interchange network (CIDIN);
>
> e) the air traffic services (ATS) message handling services; and
>
> f) the inter-centre communications (ICC).

1.2 The ensuing paragraphs show how the implementation and/or evolution of above-mentioned components of the AFS and underlying supporting infrastructures have been progressing in various International Civil Aviation Organization (ICAO) Regions.

2. IMPLEMENTATION AND EVOLUTION OF THE AFS

2.1 Basic supporting infrastructure

2.1.1 In general, AFS is essentially provided via dedicated circuits or capacity (e.g. satellite transponder). As such, air navigation service providers continue to lease circuits from communication service providers for implementing AFS components. However, in areas where reliability and availability of leased circuits are not satisfactory, States/group of States have been implementing dedicated (to ATS) communication networks . Most of such dedicated ATS networks that were implemented during the last decade, have been based on digital technology employing very small aperture terminal (VSAT) concept which provides for versatility, flexibility and ease of installation, operation and maintenance.

2.1.2 Circuits and systems that comprise the communication infrastructure for the AFS are commercial off the shelf which operate in accordance with relevant ITU-T recommendations and are implemented through bilateral or multilateral agreements between States concerned. In this connection, special coordination meetings are being conducted in some ICAO Regions to address issues associated with the interconnection of adjacent VSAT networks that are based on different satellites, access techniques or topologies.

2.1.3 A summary of recently implemented or planned regional ground networks supporting the AFS is provided below.

AFI Region

2.1.4 The AFI satellite network (AFISNET) and Southern African Development Community (SADC) VSAT networks were successfully interconnected. As a result, a number of AFTN and ATS voice circuits (e.g. between Brazzaville and Johannesburg) could be implemented.

2.1.5 The North Eastern AFI VSAT network (NAFISAT) is being developed to provide for AFS, aeronautical mobile service (AMS) (e.g. for interconnection of remote VHF ground stations) and future ATN requirements. The network will cover States in the AFI, MID and ASIA/PAC Regions. The decision to implement the project has been agreed upon and so far, eight States have confirmed their participation therein.

2.1.6 In order to facilitate the interconnection of AFI subregional and MID regional VSAT networks, it has been agreed, in principle, that AFISNET, CAFSAT, SADC and the forthcoming NAFISAT all use the same space segment and satellite access technique. The Intelsat IS-10-02, which is to be launched in November 2003, is being considered for that purpose.

2.1.7 A double hop link was successfully implemented between Las Palmas (Spain) area control centre (ACC) and Nouakchott (Mauritania) flight information service (FIS) using Dakar/Nouakchott (on AFISNET) and Dakar/Las Palmas (on CAFSAT).

2.1.8 The digitization of AFISNET in Ghana and Nigeria was successfully accomplished.

2.1.9 In addition to the provision of AFTN and ATS voice circuits, the CAFSAT network supports the transmission of European Geostationary Navigation Overlay Service (EGNOS) test bed data between Dakar reference and integrity monitoring station (RIMS) and the central processing facility located in Honefoss (Norway) through a connection made in Las Palmas. The network also supports the sharing of radar data between Las Palmas ACC and Sal (Cape Verde) ACC.

2.1.10 South Africa has commissioned a VSAT terminal of the CAFSAT network in order to implement inter-regional circuits with CAR/SAM and to provide additional connectivity within the AFI Region.

Asia/Pacific Region

2.1.11 High and medium speed data communication links are generally available to support AFS communications in a satisfactory manner. VSAT links provided by various service providers are used to upgrade AFS communication and to overcome the low reliability problem of certain leased circuits. Regulatory restriction in some States in the Bay of Bengal area is the only constraints to make use of VSAT, where required. In this regard, APANPIRG/13 had formulated a conclusion to encourage States to use VSAT technology for AFS communications, particularly in the Bay of Bengal area.

CAR/SAM Region

2.1.12 The Mejoras al Enlace de Voz del ATS (MEVA) VSAT network, which was implemented in 1996, provides voice and data communications between fifteen VSAT-equipped nodes in the Central Caribbean area. The network operates in the 4 - 6 GHz C-band on the PAS-1R satellite and uses single information channel per carrier (SCPC)/demand assigned multiple access (DAMA) technology for bandwidth-on-demand communications and circuit management. The Carribean and South American (CAR/SAM) Regional CNS Planning is expected to take into consideration the MEVA's current and future technical capabilities for establishing an aeronautical telecommunication network (ATN) backbone. Studies have been made to upgrade the MEVA network from a SCPC/DAMA system to a time division multiple access (TDMA)/frame relay system. This initiative, referred to as MEVA II, will enable the network to be directly and seamlessly interconnected with the red digital (REDDIG) TDMA VSAT system in the SAM Region as well as with other digital networks.

2.1.13 The Central American Corporation for Air Navigation Services (COCESNA) has implemented the Central American satellite network (CAMSAT) network which is based on VSAT/multi channel per carrier (MCPC)/frame relay technologies for the provision of ATS voice and data in the central American area. The MCPC technique allow the use of smaller antennas, lower transmission power, possibility of modular network growth and graceful degradation in case of individual ground station failures.

2.1.14 The Eastern Caribbean (E-CAR) network has been implemented under the PIARCO FIR. It is terrestrial open concept integrated services digital network (ISDN)-based network using optical fiber as the transmission medium. The E-CAR users are mainly located in the Eastern Caribbean. The network has one node in the SAM Region (Caracas) which will facilitate its interconnection with the REDDIG, and two nodes in the NAM Region. There are plans to introduce frame relay and other possible enhancements to the network to improve its performance as well as to facilitate its interconnection with other adjacent networks.

2.1.15 The REDDIG, which is a multi-service/multi-protocol C band VSAT network (with a meshed topology), is being implemented in the SAM Region. The network is designed to support the AFS, exchange of radar data, regional global navigation satellite system (GNSS) augmentation test data as well as the platform for introduction of the ATN ground-ground applications.

2.1.16 Studies have been conducted for the purpose of selecting the best option for interconnectivity between the MEVA II and the REDDIG networks, and also with other networks like the E-CAR and CAMSAT. The ongoing studies have been regarded by the CAR/SAM Regional Planning and Implementation Group (GREPECAS) as an important part of continuing the efforts to achieve interconnectivity and homogeneous interoperability between various regional or subregional digital communication networks.

EUR Region

2.1.17 The basic infrastructure in the EUR Region is provided by a well developed network of terrestrial fixed lines which provide the necessary interconnectivity for the AFS.

MID Region

2.1.18 Studies are under way for a MID VSAT project to overcome the deficiencies and other problems (e.g. high cost) associated with leasing communication lines from national telecommunication administrations in the region. The MID VSAT project will be designed in such a way that interoperability with other regional networks, namely the NAFISAT project in AFI Region, could be easily achieved. The results of the feasibility study for the project will be presented to the forthcoming Middle East Air Navigation Planning and Implementation Regional Group (MIDANPIRG) Meeting in September 2003.

2.2 ATS voice circuits and networks

2.2.1 New ICAO provisions relating to the use of modern digital switching and signalling scheme, in the form of Standards and Recommended Practices (SARPs) contained in Annex 10 and detailed technical specifications contained in *Manual on Air Traffic Services (ATS) Ground-Ground Voice Switching and Signalling* (Doc 9804) became available in 2001 and 2002 respectively.

2.2.2 In most regions, a mix of dedicated and switched circuits that are based on old/analog techniques are still in wide use. New switching and signalling systems that are based on recently published ICAO provisions have been subject to operational trials involving Canada, the United States, Portugal and the European Organisation for the Safety of Air Navigation (EUROCONTROL). First implementation of the new signalling scheme (designated as private signalling system No.1 (PSS1) or QSIG) between Eurocontrol's Maastricht upper airspace control (UAC) and the central flow management unit (CFMU) in Brussels was achieved in early 2003. Further implementations in Europe and between Europe and North Africa are expected to be completed by the end of 2003.

2.3 Upgrades to AFTN/CIDIN

2.3.1 In general, AFTN continues to be the main carrier of aeronautical messages worldwide. SARPs and guidance material for AFTN (contained in Annex 10, Volume II and III and *Manual on the Planning and Engineering of the AFTN* (Doc 8259)), have been essentially unchanged for many years. Morever, the flexible architecture of the network allows for coexistence and interoperation of many different circuits and systems operating at very low to medium modulation speeds. CIDIN has also been extensively used in the EUR Region (and to a less extent in the adjacent regions) in support of AFS applications. In fact, CIDIN has gradually replaced AFTN circuits in EUR/NAT to the point where it is used extensively for all the major interconnections. SARPs for CIDIN are contained in Annex 10, Volume III, while technical details, which are subject to frequent updates, are given in the *EUR CIDIN Manual* (EUR Doc 005). AFTN and CIDIN circuits and centres are continuously being upgraded to cater for increasing traffic levels.

2.3.2 The following is a summary of recent regional developments pertaining to AFTN and CIDIN:

AFI Region

2.3.3 Recent circuit upgrades to 2.4 Kbps are:

Antananarivo/Johannesburg

Brazzaville/Johannesburg

Asia/Pacific Region

2.3.4 Most of the AFTN circuits are operating at 2.4 Kbps or 9.6 Kbps using X.25 protocol. A number of low-speed circuits are still in operation at places where the traffic levels are low. There are plans to upgrade (by 2005) certain circuits to 9.6 Kbps in order to support the introduction of an ATN backbone infrastructure. A list of recent circuit upgrades is given below:

Apia/USA	2.4 Kbps
Brisbane/Singapore	2.4 Kbps
Brunei/Singapore	2.4 Kbps
Chennai/Kuala Lumpur	9.6 Kbps
Christchurch/Papeete	2.4 Kbps
Christchurch/Tongatapu	2.4 Kbps
Christchurch/USA	9.6 Kbps
Colombo/Mumbai	64 Kbps
Guangzhou/Hanoi	2.4 Kbps
Guangzhou/Sanya	2.4 Kbps
Hong Kong/Ho Chi Minh	2.4 Kbps
Hong Kong/Sanya	2.4 Kbps

2.3.5 To overcome ASIA/AFI message exchanges problem, it is expected that the existing low speed circuit between Brisbane and Mauritius entry/exit points will be replaced with a new trunk circuit between Brisbane and Johannesburg by the middle of 2003.

CAR Region

2.3.6 Most of the AFTN circuits were recently upgraded to 9.6 Kbps using X.25 protocol, which resolved most of the AFS deficiencies and is supporting the introduction of an ATN backbone infrastructure.

EUR/NAT Region

2.3.7 A recently identified CIDIN issue is the rapidly declining support for the X.25-based communication products and services, both by communications service providers and switching centre manufacturers. The Nordic States investigated the possibilities and developed an alternative solution based on the Internet Protocol (IP) . In 2002 a successful demonstration was made in Stockholm, and recently the Greenlandic system was upgraded to also handle CIDIN over IP. Successful tests of this facility were completed, and tests will continue when more systems have been upgraded.

MID Region

2.3.8 The current network is well developed, however it is not in accordance with the rationalized AFTN Plan due to the continuing presence of a multitude of bilateral circuits. A list of recent upgrades is given below:

Jeddah/Cairo and Jeddah/Bahrain - CIDIN connections at 9.6 Kbps

Jeddah/Beirut - about to be upgraded to a CIDIN connection at 9.6 Kbps

Bahrain/Kuwait - 64 Kbps digital circuit with special configuration

Kuwait/Karachi - 2.4 Kbps

Cairo/Asmara - 2.4 Kbps

2.3.9 New AFTN switching systems were implemented in Jeddah and Sanaa Centres.

2.4 ATS message handling services (ATSMHS)

2.4.1 ATS message handling services (also referred to ATS message service) is a ground-ground application of the aeronautical telecommunication network (ATN). The collection of components and systems that support the ATSMHS application is referred to as the ATS message handling system (AMHS). SARPs for the AMHS, which is envisaged to replace the ageing AFTN, were introduced in Annex 10 (as part of ATN SARPS) in 1998 and later amended (slightly) in 2001. Those SARPs are supplemented by detailed technical specifications contained in *Manual of Technical Provisions for the ATN* (Doc 9705) and guidance material contained in *Comprehensive ATN Manual* (Doc 9739). AMHS provisions include the technical specification of gateways to enable interoperability with existing AFTN and CIDIN facilities.

2.4.2 To date, most ICAO Regions have developed, or are actively developing, initial plans for the implementation of (or transition to) the AMHS. Those plans mainly involve the definition of addressing schemes and type/location/designation of various system elements.

2.4.3 Actual implementation programmes have also been initiated in EUR, APAC and between the United States and Japan. The first international operation of the AMHS is expected to occur between Salt Lake City (United States) and Tokyo in March 2004. Operations in Europe, involving Spain, France, Germany, the United Kingdom and Eurocontrol central flow management centre (CFMU) are expected to commence in 2005.

2.4.4 The recent widespread availability of hardware/software based on transmission control protocol/internet protocol (TCP/IP) has somewhat affected the AMHS planning process. In particular, in the EUR, it has been recommended that initial implementation of the AMHS be based on TCP/IP protocol suite. Also, the planning experts in APAC are considering the use of TCP/IP as the internetworking scheme of the regional AMHS infrastructure. In this regard, the Aeronautical Communications Panel (ACP) of ICAO has also included the consideration of TCP/IP in its future work.

2.5 Intercentre Communications (ICC)

2.5.1 The only type of ICC that has been standardized by ICAO is the ATS interfacility data communications (AIDC). SARPs for AIDC (as a ground-ground application of the ATN) were introduced in Annex 10 (as part of ATN SARPS) in 1998. Those SARPs are supplemented by detailed technical specifications contained in *Manual of Technical Provisions for the ATN* (Doc 9705) and guidance material contained in *Comprehensive ATN Manual* (Doc 9739).

2.5.2 Pending the widespread implementation of the ATN, regional schemes have been devised to provide AIDC functionality. Such schemes are defined by interface control documents (ICD) and vary from region to region.

2.5.3 In APAC, the service (conducted via AFTN) is available between Brisbane and Auckland and also between Tokyo and Oakland. Plans have been developed for further implementation of the service which will, initially, continue to be based on AFTN. The development of an ICD for ATN-based AIDC is currently in progress.

2.5.4 In Europe, the service is called on-line data interchange (OLDI) and is conducted over dedicated/private X.25 connections and networks. OLDI is extensively used for communications between controllers concerning active flights. For the same reasons that were mentioned previously, plans have been drawn to transfer OLDI to IP-based connections and networks.

2.6 Meteorological operational circuits, networks and broadcast systems

2.6.1 Satellite distribution systems for MET information are the most significant issue with respect to the use of the AFS for meteorological applications. These satellite broadcasts provide global coverage and transmit world area forecast system (WAFS) products and operational meteorological (OPMET) data in accordance with provisions of Annex 10.

2.6.2 These comprise the international satellite communications system (ISCS) provided by the United States, which operates two of the uplinks: ISCS(1) serving the North and South American Regions, the North Atlantic Region, and the Central America and Caribbean Region, through an INTELSAT Atlantic Ocean satellite, and ISCS(2) serving the Pacific Region and the eastern part of the Asia Region through an INTELSAT Pacific Ocean satellite. The third uplink, which is provided by the United Kingdom, comprises the Satellite Distribution System for Aeronautical Information Relating to Air Navigation (SADIS), serving the European, Middle East and African-Indian Ocean Regions, and the western part of the Asia Region, through an INTELSAT Indian Ocean satellite. The operation and development of the SADIS is managed by the SADIS Operations Group (SADISOPSG). The total number of States/Members receiving the satellite broadcasts is now over 160, comprising around 200 VSATs.

2.6.3 Three sites (located in Senegal, South Africa and Switzerland) under the footprint of the SADIS broadcast have a two-way capability for the purpose of sending OPMET data (and potentially other aeronautical data) back to the SADIS uplink station.

2.6.4 Most of the workstations and the corresponding software used in the States under the SADIS footprint will also have to be upgraded in order to provide capability of processing binary universal form for the representation of meteorological data (BUFR) coded significant weather (SIGWX) products, which would replace the current T.4 coded SIGWX charts by mid 2005.

2.6.5 A backup facility operated by the SADIS Provider State using Internet-based file transfer protocol (FTP) service has been implemented in response to a conclusion formulated by the SADISOPSG. It became operational during 2002. The backup service is available for all the authorised users of both SADIS and ISCS.

2.6.6 All the workstations under the ISCS footprint will have to be replaced during 2003 since the ISCS broadcasts will switch to the TCP/IP protocol by the end of 2003 and the current workstations are incompatible with the new protocol.

2.7 Use of the public Internet

2.7.1 Internet is a public medium and therefore cannot be considered as part of the AFS. However, its widespread availability, high speed, low cost and ease of use has been appealing to the aviation community to the extent that some States and international organizations have started using it for operational communications. In this regard, ICAO has established a new study group to develop guidelines on the use of the public Internet for aeronautical applications with due consideration to accessibility, reliability, integrity and security issues. The subject guidelines are expected to be completed in mid 2004.

3. CONCLUSION

3.1 Evolution of the AFS is incremental and gradual. Operational, technical and/or economical benefits offered by emerging technology are being explored and exploited where and when warranted, but for the foreseeable future, various combinations of older and newer systems will have to coexist and interoperate.

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