AFI AMHS Manual

AFI AMHS Manual	
Document Reference:	AFI AMHS Manual, Main Part
Author:	AFI AMHS Taskforce Team
Revision Number:	Version 1.0
Date:	21/07/2011
Filename:	AFI AMHS Manual_V1.0.doc

Document Control Log

Edition	Date	Comments	section/pages affected
1.0	21/07/2011	Created from EUR AMHS Manual V6.0	All

Scope of the Document

This document has been developed by the ICAO AFI AMHS Taskforce Team in order to present a comprehensive collection of information pertaining to the implementation of ATSMHS in the ICAO AFI Region.

It is intended that the document will evolve into an AFI ICAO Document containing guidance material on AFI AMHS implementation.

Table of contents

LIST OF APPENDIXES OF THE AFI AMHS MANUAL

References

ICAO Documentation

[1] ICAO Annex 10 – Aeronautical Telecommunications, Volume II and Volume III

[2] ICAO Annex 11 – Air Traffic Services

[3] ICAO Doc 9880-AN/466: Manual on Detailed Technical Specifications for the Aeronautical Telecommunication Network (ATN) using ISO/OSI Standards and Protocols, Part II – Ground-Ground Applications - Air Traffic Services Message Handling Services (ATSMHS), First Edition – 2010

[4] ICAO Doc 9880-AN/466: Manual on Detailed Technical Specifications for the Aeronautical Telecommunication Network (ATN) using ISO/OSI Standards and Protocols, Part III – Upper Layer Communications Service (ULCS) and Internet Communications Service (ICS), , First Edition – 2010

[5] ICAO Doc 9880-AN/466: Manual on Detailed Technical Specifications for the Aeronautical Telecommunication Network (ATN) using ISO/OSI Standards and Protocols, Part IV – Directory Services, Security and Systems Management, First Edition – 2010

[6] ICAO Doc 9896-AN/469: Manual on the Aeronautical Telecommunication Network (ATN) using Internet Protocol Suite (IPS) Standards and Protocols, First Edition – 2010

[7] ICAO Doc 7910, Location Indicators,

[8] ICAO Doc 8585, Designators for Aircraft Operating Agencies, Aeronautical Authorities and Services

[9] ICAO Doc 8259-AN/936: Manual on the Planning and Engineering of the Aeronautical Fixed Telecommunication Network, Fifth Edition – 1991

[10] ICAO Doc 7754, Vol. I, EUR BASIC ANP Basic Air Navigation Plan – EUR Region – [11]

ICAO Doc 7754, Vol. II, EUR ANP (FASID) Facilities and Services Implementation Document (FASID) – EUR Region –

[11] EUR Doc 021, ATS Messaging Management Manual

[12] EUR/NAT AMHS PRMD Names and Addressing Plan Registry

General technical literature

[13] ISO/IEC 10021-2: Information Technology – Message Handling Systems (MHS): Overall architecture

[14] ISO/IEC 10021-10 International Standard, Information technology – Message Handling Systems (MHS): MHS routing (1998)

Table of Figures

Index of Tables

1 Structure of the AFI AMHS Manual

1.1 The AFI AMHS Manual consists of the "Main Part" and the Appendices.

1.2 In the main part, the following Chapters have been introduced, with the view to provide general guidance and detailed information on requirements concerning AMHS implementation in the AFI Region.

1. Introduction
2. AFI AMHS Requirements
3. AFI ATS Messaging Service Profile
4. System implementation - Guidelines for system requirements
5. AMHS management
6. Tests and validation of systems
7. Operational procedures and Recommendations
8. Miscellaneous

1.3 Then, for easy reference, the Change Control Mechanism of the AFI AMHS Manual has been included as Attachment A.

1.4 Finally, for better presentation and management, detailed documents, which have been produced on particular subjects initially addressed in the main body of the Manual, have been included as Appendices to the Manual.

1.5 The following Appendices to the AFI AMHS Manual have been produced:

Appendix A: Abbreviations, Glossary and Definitions

Appendix B: AFI ATS Messaging Service Profile

Appendix C: AMHS Testing Requirements

Appendix D: AMHS Conformance Tests

Appendix E: AMHS Interoperability Tests

Appendix F: AMHS Pre-operational Tests

1.6 *Note. – The AFI AMHS Manual is a "living" document. The AFI AMHS Taskforce Team, as the editor, has collected necessary and relevant information to be used for the Regional deployment of AMHS. All interested partners are invited to contribute. Do not hesitate to contact the Taskforce Team; each comment, remark or correction is welcome.*

2 Introduction

2.1 Background Information

2.1.1 AFS

2.1.1.1 The Aeronautical Fixed Service provides, among other things, for the exchange of messages pertaining to the safety of air navigation and the regular, efficient and economical operation of air services.

2.1.1.2 The following categories of message are handled by the AFS:

distress and urgency messages

flight safety messages

meteorological messages

flight regularity messages

aeronautical information services messages

administrative messages

service messages

2.1.1.3 The principal users of messages in the above categories are ATS and the AIS, ATFM, MET and SAR Services which support and complement the ATS.

2.1.2 AFTN

2.1.2.1 Initially, the operational requirements for such an information exchange were met by the development of the Aeronautical Fixed Telecommunications Network.
The AFTN provides a store-and-forward messaging service for the conveyance of text messages in ITA-2 or IA-5 format, using character-oriented procedures.
Although AFTN served its purpose well for many years, AFTN technology has become outdated due to the fact that is remains bound to its telex/telegraphic origins.

2.1.2.2 One major step towards overcoming the limitations of the AFTN was taken with the introduction of the Common ICAO Data Interchange Network, which is based on packet switching techniques.

2.1.3 AMHS

2.1.3.1 The most recent development with regard to messaging in the ATS environment is the AMHS. The AMHS is a natural evolution from AFTN, replacing the telegraphic style of working with a modern Message Handling System based on international Standards.

2.1.3.2 It is presumed that the ATSMHS, being an ATN application, utilises the infrastructure of the ATN internetwork. However this is not a prerequisite for the initial deployment of the ATSMHS.

2.1.3.3 There are several advantages of AMHS over AFTN including:

increased speed, capacity and throughput

enhanced reliability

extended functionality

interoperability with other global messaging services

security capabilities

use of COTS equipment and services

Furthermore, AMHS offers services meeting non-AFTN communication requirements.

2.1.3.4 The provisions pertaining to ATSMHS, such as SARPs, technical specifications and general guidance material, are contained in the following ICAO documents, which constitute the main references for this Manual.

Annex 10, Volume II, Chapter 4 [1]

Annex 10, Volume III, Part I, Chapter 3 [1]

Doc 9880 Part II [3]

ICAO EUR BASIC ANP[10]

ICAO EUR ANP (FASID) [11]

2.2 ATSMHS Overview

2.2.1 General

2.2.1.1 The ATN technical specifications for the Air Traffic Services Message-Handling Service (ATSMHS) define the ICAO store and forward messaging service used to exchange ATS messages between users over the ATN internet.

2.2.1.2 The set of computing and communication resources implemented by Air Navigation Service Providers (ANSP) to provide the ATS Message Handling Service is commonly referred to as AMHS (ATS Message Handling System).
The ATS Message Handling System technical specifications are compliant with mature message handling systems standards such as ISO/IEC 10021 [23] and ITU-T X.400.

2.2.2 Functional Components

In terms of functionality, the ATSMHS comprises the following components:

(a) the Message Transfer Agent (MTA) which performs the function of the message switch,

(b) the User Agent (UA) which performs the user access to the MTA and provides an appropriate user interface,
(c) the Message Store (MS) which provides the intermediary storage between MTA and UA and is usually co-located with the MTA, and
(d) the Access Unit (AU) which provides for intercommunication with other Messaging Systems.

2.2.3 End systems

2.2.3.1 Three categories of ATN end systems are defined for the support of the ATS Message Handling Service:

the ATS message server
the ATS message user agent
the AFTN/AMHS gateway

2.2.3.2 Together, these systems provide connectivity between users at ATN end systems and users at AFTN Stations in three different end-to-end configurations:

a) from an AFTN Station to another AFTN Station over the ATN;
b) from an AFTN Station to an ATN End System, and vice versa;
c) from an ATN End System to another ATN End System.

2.2.4 Levels of service

2.2.4.1 Two levels of service are defined within the ATS Message Handling Service:

1. The Basic ATS Message Handling Service;
2. The Extended ATS Message Handling Service.

2.2.4.2 The Basic ATS Message Handling Service meets the basic requirements of the MHS Profiles published by ISO as International Standardized Profiles (ISPs), and it incorporates additional features to support the service offered by the AFTN.

2.2.4.3 Compared to the service of the AFTN, the Basic ATS Message Handling Service offers some significant improvements such as:

practically unlimited message length;
virtually no limit on the number of addressees of a message;
provision of non-delivery reports;
indication of the subject of a message.

2.2.4.4 The Extended ATS Message Handling Service provides functionality in addition to those of the Basic ATS Message Handling Service such as the introduction of directory services and security mechanisms. Furthermore, in addition to IA-5 text, the extended service allows for the transfer of binary coded data, files etc.

2.2.4.5 The Extended ATS Message Handling Service is backwards compatible with the Basic ATS Message Handling Service.

2.2.5 Inter-operability

2.2.5.1 During the transition phase from the AFTN to the AMHS the interoperability between systems is achieved by the use of the AFTN/AMHS gateway.

2.2.5.2 The technical specifications for the AFTN/AMHS gateway have been defined by ICAO.

3 AFI AMHS Requirements

3.1 Quality of Service Requirements

3.1.1 Scope

3.1.1.1 The purpose of this section is to define quality of service (QoS) requirements and set target performance objectives for the AFI AMHS. To this end, the properties of the AMHS are considered from the outside of the network, i.e. at its boundary, without taking into account the way in which the service, as defined on its boundary, is provided from within the network.

3.1.1.2 The performance requirements dealt with in this section are the common understanding on what the applications will get in terms of performance and what level of performance the network has to provide. The performance parameters are therefore necessary for designing applications as well as the network itself.

3.1.1.3 This section is organised as follows:

3.1.1.3.1 First, a collection of terms and concepts is set up for discussing quantitative properties of the service delivered by the AMHS.

3.1.1.3.2 Second, numerical values for performance parameters are defined using the following input:

anticipated location of message servers and gateways;

analysis of existing and projected message flows in the AFI area based on presently available information;

general design principles;

user expertise.

3.1.1.4 As in most cases, in order to arrive at concrete values for the performance parameters, a number of assumptions and restrictions are made:

QoS is not dependent on traffic volumes;

QoS is measured between originator-recipient pairs;

QoS is not geographically dependent;

QoS is not dependent on time;

QoS represents worst case performance;

the underlying network should be sized to accommodate QoS;

degree of corruption is not relevant to the Corruption QoS parameter;

corruption is not dependent on message size;

non reachability due to network causes is typically of the order of a few minutes (60 per year);

the bit error rate of an HDLC link is of the order 10^{-11}.

3.1.2 Quantitative approach

3.1.2.1 The formal analysis and formulation of network performance requirements is a difficult task and the pragmatic solution often adopted is to over-dimension the network, resulting in sufficient capacity and service assurance but also significantly higher costs. At a time when ANSPs are becoming increasingly cost conscious, this solution is not acceptable.

This sub-section gives an overview of the problems of quantitative analysis of message handling with special reference to the AMHS.

3.1.2.1.1 Comparison with the development of CIDIN

The introduction of CIDIN in Europe was done with new technology over a period of 15 years, with no overall CIDIN capacity planning. The CIDIN development is characterised by continual upgrading.

In the case of the AMHS, the technology is not new, but is well tried. For this reason it makes sense to establish quantitative performance requirements for it from the beginning. Unfortunately, there is very little experience available and techniques for the specification of performance requirements for message handling systems do not exist.

3.1.2.1.2 The process of continual upgrading

Since the task of specifying numerical requirements is so difficult, most networks experience a process of continual upgrading in order to correct errors in the initial numerical requirements estimates but also to cope with increasing demands on performance. A typical approach of network operators is to keep utilisation of individual network components below a certain level, e.g. 50%. As soon as this level is reached in a component, it is upgraded. This is based on the experience that when components reach high utilisation levels, highly non-linear effects occur and the performance of the network as a whole is no longer predictable.

3.1.2.2 Quantitative aspects of the AMHS

3.1.2.2.1 Messages as the basis of the analysis

In dimensioning the AMHS only complete messages should be considered for the following reasons:

- the message is the basic unit of data at the user interface;
- whole messages are stored and forwarded by MTAs in the network;
- in formulating performance requirements, transport or sub-network performance is not taken into account.

Of course, in dimensioning the network, it will be necessary to consider performance aspects of lower level infrastructure as well, but as a result of the user requirements formulated in this document and their impact on MTA performance.

Further, it is important to note that the specification of performance requirements is based on individual messages, independently of all other messages.

When considering message size, only the volume of user information is relevant since the user has no control (or only very limited control) over the data overhead involved in message handling.

Formulating performance requirements of a given user, taking into account the simultaneous use of the network by other users, does not appear to be feasible. However, it has to be recognised that, in a real world situation, the performance of the network for a given message certainly does depend on the presence of other messages currently being processed.

3.1.2.2.2 Types of performance parameters

There are two distinct groups of performance parameters to be considered in connection with the AMHS.

Parameters not dependent on message volumes: These parameters describe the quality of service (QoS), which is available to each individual message considered by itself, e.g. transit time. They can be measured, i.e. they are the quantitative results of the way in which messages are handled by the network.

Message volumes: These parameters describe the volumes of messages, message sizes and their distribution geographically, as they could be generated by users of the network. The parameters could be measured in the user end systems but it is not realistic to measure them in the network.

3.1.2.2.3 QoS per individual message

QoS requirements have to be satisfied under worst possible/allowable traffic volumes and most unfavourable originator/recipient pairs within a specific network configuration. Consequently, QoS is formulated for each individual message, independently of other messages being handled by the network.

This choice has been made for the following reasons:

it is difficult to imagine that users would accept a QoS which is dependent on the demands which other users place on the network at the same time;

the network has to be dimensioned to handle the maximum message volumes, while performing sufficiently well;

the QoS requirements represent "worst case" performance when maximum degradation through interaction with other traffic occurs.

It must be pointed out, that AMHS provides the facilities to send messages many orders of magnitude greater than AFTN, with attachments measured in Mb. Clearly transfer times for such messages will be considerably longer than for the short text messages exchanged in AFTN. It is, thus, necessary to qualify the statement that QoS is independent of message size by adding ‘for messages containing similar information to that carried over the AFTN’. If a quantitative limit is required, this will be between 4Kb and 6Kb, being the equivalent size of an AFTN message including the AMHS header.

3.1.2.2.4 Independence of QoS on location and time

QoS for an originator/recipient pair is most likely dependent on the relative locations of the two end systems, i.e. whether messages are transmitted with more or less hops through MHS systems (MTAs etc.). However, for simplicity reasons and since QoS requirements are "worst case" requirements, they are stated independently of the location of a message server.

Furthermore, QoS requirements remain constant at all times and are not dependent on date and time of day.

The AMHS performance requirements for the AFTN/AMHS Gateways, could, by agreement, be deemed to apply to interfaces between AMHS functions and AFTN functions in Gateways, e.g. a boundary point consisting of an interface between an internal Message Store and an AFTN handler within a Gateway.

3.1.2.2.5 Dependence of QoS on the AMHS service used

It may be necessary to specify different QoS levels for the AMHS corresponding to different sets of services used, i.e. there may be different classes of messages with respect to QoS. The number of QoS levels should be kept small for simplicity and the way in which service parameters map a message to a QoS level must be simple.

The values of QoS provided by the AMHS are useful to the application designer in deciding which services to use and how they are used. For example, the degree of certainty that a message will reach its destination will determine whether AMHS acknowledgement services are used and in what way. Furthermore, the values of QoS are useful in designing higher-level protocols.

3.1.3 Specification of performance requirements

3.1.3.1 The specification and meaningful application of performance requirements is not a simple task. This sub-section outlines some of the difficulties involved and principles to be adopted.

3.1.3.1.1 Statistical significance

The way in which performance parameters are formulated is necessarily statistical in nature. This is due to the large number of factors, which affect the performance of the network, such as:

the current network configuration;

the current overall load of the network, i.e. the behaviour of all users considered as a whole; and

the dynamic properties of network nodes and transmission systems.

3.1.3.1.2 The need for measurement

For the specification and application of performance requirements to be meaningful, there has to be a framework for measuring performance with respect to the performance parameters. Aspects of a measurement framework which have to be considered are:

because of the non-deterministic nature of network performance, measurements need to involve large samples of messages, as described in the previous section;

measurements must be made at different locations simultaneously;

consistent decisions have to be made as to where measurements are performed, e.g. at service interfaces in MTAs, UAs etc.

3.1.3.1.3 Network aspects relevant to performance

The following list contains factors which can affect message handling performance:

processing speed, limits the capacity due to the store and forward nature of message handling;

the finite transmission capacity (line speed) of links between nodes, limits the network throughput;

the transmission times across links, affects the message transit time since complete messages are stored and forwarded a number of times between originator and recipient;

the efficiency of message queues;

transmission line failures and errors are obvious sources of degraded performance;

table configuration errors can have major negative effects on network performance;

software failures, which are difficult to treat quantitatively.

In designing the network, the performance requirements (amongst other things) have to be translated into properties of individual network components such that overall requirements are satisfied. Of course other considerations such as policy, expandability, ease of maintenance etc. enter into the network design as well.

3.1.3.2 AMHS Quality of Service Requirements

3.1.3.2.1 For reasons of completeness, simplicity and relevance, a minimal set of parameters was selected out of the large range of possibilities for expressing performance properties, to form a suitable "frame of reference" for discussing the dynamic properties of the AFI AMHS:

These parameters defined and described in the following sub-sections in more detail, are:

Destination Non-Reachability;

Maximum Transit Time;

Message Corruption.

The selection of these three parameters has been made for the sake of: Completeness:

all relevant performance aspects of AMHS are covered; Simplicity: the

formulation of requirements is intentionally kept simple; and Relevance: no

aspects are included which are not considered to be relevant.

If the performance of the AMHS is such that these parameters are exceeded, then the service is deemed to be of poor quality.

3.1.3.2.2 Destination Non-Reachability

Destination Non-Reachability is expressed with respect to pairs of addresses (originator / recipient). It is the probability that a message sent by the originator will not reach the recipient within the Maximum Transit Delay (as defined below).

The above definition shows that the parameters Destination Non-Reachability and Maximum Transit Time (see below) are not independent of each other: their definitions are coupled. This is intentional. The philosophy behind this definition is that the value of a message to a person or an application receiving it is dependent on its timely receipt. It is assumed, for a given flow type, that all messages belonging to it have the same value of this parameter.

The definition of Destination Non-Reachability is independent of whether the long (or infinite) transit time for a message is reported to its originator or not. It is also independent of whether acknowledgement procedures within the AMHS or on an application level detect the long (or infinite) transit time or not.

Destination Non-Reachability includes the cases in which messages are “lost”, i.e. do not reach their destination in finite time. The probability of message loss must be negligible and this probability is included in the total probability of Destination Non-Reachability. However, there remains a need (for procurement purposes) to place a separate figure on this probability. In keeping with the above rationale, it is required that the probability of message loss is, at most, one tenth of the probability of Destination Non-Reachability.

3.1.3.2.3 Maximum Transit Delay

The Maximum Transit Delay is the time within which a single message has to be transmitted through the network end-to-end so that its transmission is of value to the applications (users).
If this time is exceeded, the receipt of the message is, in principle, of no value to the application. If the non-receipt within this time is known to the application, then, presumably, error procedures, such as message retransmission, will be initiated.

The transit delay is the time taken by the network to make the message available to the Message Store associated with the message recipient (UA). Therefore the boundary points of the network may, in this context, be considered to be the MTAs connected to the UAs serving the originators/recipients. The boundary points can also be the MTA functionality within AFTN/AMHS Gateways.

It must be borne in mind, that the parameters Maximum Transit Delay and Destination Non-Reachability only have significance when they are taken together.

3.1.3.2.4 Message Corruption

The third Quality of Service Parameter concerns message integrity and is called "Message Corruption". It is the probability that each 1,000 octet content block of a message which arrives at its destination, has been corrupted in any way. The definition of Message Corruption applies only to messages which reach their recipients within the Maximum Transit Delay.

"Corruption" means a deviation, end-to-end, of the content of the received message from the content of the original message. The "content" is also deemed to include parameters, such as originator address, which are delivered together with the message. Corruption can also result from unauthorised changes to a message.
Since the volume unit for defining Message Corruption is large (1,000 octets), the requirement is almost independent of the size of (current) messages. This simplification is

based on the assumption that corruption is due to unforeseen system malfunctioning, e.g. faulty software. The corruption of messages due to such causes is not likely to be dependent on the size of messages. (This is true today, but the upcoming use of ADEXP messages-with message lengths up to 10koctets-has to be mentioned, as well as the potential forthcoming applications interchanging messages with binary body parts).

The probability of corruption due to other parameters such as system load, queue sizes, transmission errors etc. is almost negligible.

It is estimated, that the volume dependent non-detected bit error probability for a 1000 octet message traversing the AMHS and involving 5 links and 5 different systems (MTAs, UAs, MSs) is of the order of one bit in 10^5 or less. This justifies the (almost) volume-independent character of the Message Corruption parameter.

3.1.3.3 QoS Flow Type Classes

3.1.3.3.1 Different types of information exchange, called Flow Types here, place different QoS requirements on the AMHS.

In principle, each Flow Type might need to be associated with its own specific values of the three QoS parameters. However, taking into account the large number of possible Flow Types, this would result in a very complex analysis. A suitable approach to reducing this complexity is the introduction of “QoS Flow Type Classes” as follows:

Define a number of "QoS Flow Type Classes" and associate a set of fixed values of the three QoS parameters with each class. Depending on the properties and needs of applications using specific Flow Types, assign these to the QoS Flow Type Classes.

When engineering the network, message traffic volumes of each class need to be taken into account rather than individual Message Flow Types.

3.1.3.3.2 Three QoS Flow Type Classes

The approach outlined above is simple and practical provided the number of classes is small. In addition, there is a requirement that the QoS Flow Type Class, to which a message belongs, can be coded in some way in the message itself. This requirement comes from the fact that all AMHS components, e.g. MTAs, must be able, at least in principle, to adapt their processing to the QoS Flow Type Class. The means for this coding must come from standard MHS protocol elements, since development specific to AMHS has to be avoided and the possibility of using third-party-service must be kept open. This rules out, for example, the representation of QoS Flow Type Classes by specific User Parts.

The use of the MHS message priority parameter with three values, "urgent", "normal" and "non urgent", belonging to the P1 protocol handled by MTAs, is currently also not suitable for this purpose. The association of values to messages originating from and destined for the AFTN is fixed by technical specifications, since such messages traverse an AFTN/AMHS Gateway. This means that values of the MHS priority parameter cannot be freely assigned to message types which are currently handled by the AFTN.

There is no short-term solution to this problem. However, in the long-term, when the majority of messages handled by the AMHS are originated by and destined for native users, the priority parameter may become available for this purpose, keeping in mind, nevertheless, that various practical issues may need to be resolved.

3.1.3.3.3 In keeping with the three possible values of the MHS message priority parameter, three corresponding QoS Flow Type Classes are defined:

a) <u>The "High QoS" Flow Type Class</u>

Properties of this QoS Flow Type Class are:

message transmissions are part of procedures, i.e. the sending and receipt of messages necessarily lead to actions or processing. Without receipt of the message, these actions or processing would not take place, or

any corrupt information in messages could have serious consequences. This possibility has to be negligible.

b) <u>The "Medium QoS" Flow Type Class</u>

This class has similar properties to the High QoS Flow Type Class; however the Maximum Transit Time requirement can be somewhat less stringent. This distinction is important, because it can be expected that the Maximum Transit Time requirement will have a sensitive effect on network dimensioning.

Properties of this QoS Flow Type Class are:

message transmissions tend to be of the nature of "information distribution" or "broadcast", possibly based on distribution lists rather than being parts of operational procedures. They are normally not acknowledged. Transit time and reachability constraints are not critical. In the case of non-delivery of messages, this may be noticed by users, in which case backup activities could be initiated, or

message corruption could have serious consequences and needs to be as low as for the previous class.

c) <u>The "Low QoS" Flow Type Class</u>

This class has similar properties to the Medium QoS Flow Type Class; however the Destination Non-Reachability and Message Corruption requirements can be somewhat less stringent. This is due to a certain amount of redundancy in the message contents and/or the regular updating and transmission of messages with similar content.

3.1.4 Application of performance requirements

3.1.4.1 The QoS parameters are obviously of importance to the network operators, users and application designers.

3.1.4.2 The QoS requirements along with the volume requirements for each of the Flow Type Classes at the boundary of the network (servers and gateways) are used, in conjunction with a set of well defined design principles (see 3.3 AMHS topology), in order to:

determine the local performance of servers and gateways, thus dimensioning their configuration,

determine the throughput of MTAs and capacity of links,

draft possible network configurations and select the "optimum" network design, and measure actual network performance.

3.1.5 Measurement

3.1.5.1 The specification of numerical values for Performance Requirements is meaningless unless provision is foreseen for measurement of network performance. Such measurement is needed:

when implementing and enforcing Service Level Agreements between AMHS service providers and users;

for acceptance testing of network components;

to determine network capacity;

to gain experience in network operation (e.g. testing of various routing strategies, etc.).

to manage the network efficiently.

3.1.5.2 Technically, network performance measurement involves, among other things:

generation of large message/data volumes;

automation of measurement;

time-stamping of messages;

use of statistical analysis.

3.2 AMHS Addressing

3.2.1 Introduction

3.2.1.1 This section aims at the production of the AMHS Addressing Plan for all the potential AMHS users in the AFI Region. This Plan should define the AMHS users addressing in an intuitive way and it should be comprehensible and meaningful to the human user and independent of the use (or not) of any type of Directory service such as X.500.

3.2.1.2 The Addressing Plan should also provide the rules to extend the addressing defined to other ANSPs (or not yet identified users).

3.2.2 Requirements

3.2.2.1 The AMHS addressing scheme should meet all of the following requirements:

The addressing scheme should be as uniform as possible across all AMHS implementations in different Regions (as it is currently the case for AFTN addresses);

The same addressing scheme should be maintained when indirect AMHS users (i.e. AFTN users or CIDIN users) migrate to AMHS. This implies that the AMHS addressing scheme is pre-defined and published before actual operation of the newly implemented AMHS;

The addressing scheme should be independent of any constraints that may be imposed by Management Domains (MDs) in the Global MHS (i.e. the non-AMHS services operating globally as commercial services) or by national regulations that may vary from Region to Region; and

The addressing scheme should allow for the interchange messages with MDs in the Global MHS.

3.2.3 MHS Addressing structure

Each MHS address consists of a set of MHS standard components referred to as address attributes.

3.2.3.1 High level MHS address attributes

3.2.3.1.1 The high level MHS attributes identify an MHS Management Domain as specified in ISO/IEC 10021-2, Section 18.3 [22]. They are determined by the structuring of Management Domains of the MHS Region/organisation to which the address belongs. Each attribute must be registered with an appropriate registration authority to ensure that all addresses remain unambiguous. They are as follows:

Country (C) Name: this is mandatory, and the possible range of values of the attribute is drawn from the ISO 3166 register of country names. The register contains a special value 'XX', allocated for the purposes of international organisations (i.e. those that are established by international treaty) which do not ‘reside’ within any particular country;

Administrative Management Domain (ADMD) Name: this is mandatory, and its value is the name of an MHS Service provider in the context of a particular country. ADMD Names must be registered by a national registration authority. ADMDs registered under the 'XX' country must obtain that registration from the Telecommunication Standardisation Sector of the International Telecommunication Union (ITU-T);

Private Management Domain (PRMD) Name: this is optional, and its value is the name of an MHS service usually operated by a private organisation. PRMD names must be registered either with their respective ADMDs, or with a national register of PRMDs.

3.2.3.1.2 For example, the high level address of a PRMD in the United Kingdom might be:

C = GB; ADMD = BT; PRMD = British Gas;

3.2.3.2 Low level MHS address attributes

3.2.3.2.1 They are as follows:

Organisation name: the organisation name is the most significant naming attribute of the O/R address. Many organisations will operate as sub-naming authorities, allocating name space below their organisation name attribute. The function of the domain names, both Administrative and Private, is to provide a relaying mechanism for delivery of the message to the intended destination. Relaying to the intended destination is made easier by the combination of a unique Organisation Name within a unique PRMD name, thus ensuring that all MHS organisations are uniquely identified.

Organisational unit name: the organisational unit (OU) names are used within the context of a hierarchical addressing structure as identified by the organisation name attribute, and should be used to identify meaningful subdivisions of that namespace. The X.400 O/R address allows for up to 4 occurrences of the OU name attribute to be specified, each up to 32 characters in length, in descending order of significance within the organisational hierarchy.

The other *OU name* (*OU2-4*) attributes can be used to further subdivide the namespace represented by the *OU1* attribute if necessary. Subordinate OU names should only be used if all superior OU names are in use.

Common Name: The common name attribute is the preferred way of identifying distribution lists and computer applications, avoiding the (mis)use of the personal name attribute. The common name attribute can be up to 64 characters in length.

3.2.3.2.2 A complete list of attributes with different information concerning on the maximum length and type of allowed characters for each attribute type is provided in the following Table:

MNEMONIC FORM ADDRESS ATTRIBUTE	CHARACTERISTICS
Country name	2 alpha or 3 numeric
ADMD name	16 PrintableString
PRMD name	16 PrintableString
Organisation name	64 PrintableString
Organisational unit name	32 PrintableString
Common name	64 PrintableString

Table 1: Mnemonic O/R address attributes maximum length and types

3.2.4 AMHS Addressing Schemes

3.2.4.1 XF-Addressing Scheme

3.2.4.1.1 The AMHS technical specifications describe a potential AMHS addressing scheme, the XF-Address (translated), composed of the following:

a) an AMHS Management Domain identifier;

b) an organisation-name attribute:

1) as specified in ISO/IEC 10021-2, Section 18.3,

2) taking the 4-character value “AFTN”, and

3) encoded as a Printable

String; and c) an organisational-

unit-names attribute:

1) as specified in ISO/IEC 10021-2, Section 18.3,

2) comprising a sequence of one single element, which takes the 8-character alphabetical value of the AF-Address (AFTN-form address) of the user, and

3) encoded as a Printable String.

Note1. – An XF-Address is a particular MF-Address whose attributes identifying the user within an AMHS Management Domain (i.e. those attributes other than country-name, administration-domain-name and private-domain-name) may be converted by an algorithmic method to and from an AF-Address. The algorithmic method requires the additional use of look-up tables which are limited, i.e. which include only a list of AMHS Management Domains rather than a list of individual users, to determine the full MF-address of the user.

Note2. – An MF-Address (MHS-form address) is the address of an AMHS user.

3.2.4.1.2 A summary of XF-Addressing Scheme can be found in the following table:

Attribute	Attribute value	Remark
Country-name ©	C = “XX”, as already obtained by ICAO from ITU-T	
ADMD-name (A)	A = “ICAO”, as already registered by ICAO at ITU-T	

<table>
<tr><td>PRMD-name (P)</td><td>P = private-domain-name, taking the value of the one or two-letter ICAO Nationality Letters as specified in Document 7910.</td><td>Default value will be used to ensure that the attribute value is always defined (see [13]).</td></tr>
<tr><td>Organisation-name (O)</td><td colspan="2">O = “AFTN”, taking the 4-character value “AFTN” encoded as a Printable String.</td></tr>
<tr><td>Organisational-unit-name (OU1)</td><td colspan="2">OU1 = the 8-letter AF-address (or AFTN indicator) of the considered user.</td></tr>
</table>

Table 2: XF-Addressing Scheme

Example: XF AMHS Address for the ***Nairobi Tower***
/C=XX/A=ICAO/P=***HK***/O=AFTN/OU1=***HKNA***ZTZX

3.2.4.2.1 High-level attributes

3.2.4.2.1.1 The following preferred high-level MD and address structure that meets all of the requirements outlined in paragraph 3.2.1 above:

Country Name = 'XX';

ADMD Name = ‘ICAO’;

PRMD Name = preferred operating name assigned by each ANSP or group of ANSPs.

In this way, ICAO creates an international ADMD without addressing constraints imposed from outside ICAO and its members.

3.2.4.2.1.2 This scheme has placed two requirements on ICAO:

To obtain from the ITU-T the registration of the name ‘ICAO’ (or some other suitable acronym agreed between ICAO/ANC and ITU-T); and

To establish and maintain a register of PRMDs established by ANSPs that operate using the 'XX' + ‘ICAO’ address structure, in a way similar to Doc 7910 [7]and Doc 8585[8].

*Note. – This scheme does **not** require ICAO itself to operate the ADMD systems since this should be delegated to the participating ANSPs.*

3.2.4.2.1.3 This registration will enable the establishment of regional AMHS services and their later interconnection, and it will provide ANSPs with a good deal of stability within which they can develop their AMHS plans.

3.2.4.2.2 Low level attributes

3.2.4.2.2.1 The CAAS addressing scheme includes the following attributes:

Organisation name (O) = Region,

Organisational unit 1 (OU1) = Location,

Common name (CN) = User

3.2.4.2.2.2 Consequences:

Each ANSP will define the values for the Organization-Name attribute (O) in its Management Domain. The character set to be used for this attribute will be the set of characters allowed by the ASN.1 type "PrintableString".

Organisational Unit 1 (OU1) will be the 4-character ICAO location indicator (as specified in ICAO Doc 7910 [7]) of the user.

Common Name (CN) will include the 8-character AFTN address for AFTN users.

3.2.5 AFI AMHS Addressing Plan

3.2.5.1 AFI AMHS Addressing Scheme

3.2.5.1.1 AFI AMHS Addressing Scheme will be endorsed by the ??? meeting of the AFI AMHS Taskforce team.

3.2.5.1.2 This scheme has been adopted for potential AFI AMHS users, both already identified and users not currently defined.

3.2.5.1.3 This section consists of the Addressing Plan to be used by AFI Organisations implementing AMHS and a database in which addresses of potential users are collected.

3.2.5.1.4 Major concepts of this AFI AMHS Addressing Plan are shown as follows:

Attribute	Attribute value	Remark
Country-name (C)	C = "XX", as already obtained by ICAO from ITU-T	
ADMD-name (A)	A = "ICAO", as already registered by ICAO at ITU-T	
PRMD-name (P)	P = a name to be defined by each ANSP and registered by ICAO. Such a name will identify a State, an Organisation, or an organisation within a State.	In the absence of such a name being registered by the ANSP at ICAO, a default value will be used to ensure that the attribute value is always defined. This default value is the ICAO two letter State/territory identifier, as may be found in Doc 7910.
Organisation-name (O)	O = a value corresponding to local/national geographical information, e.g. a region or a geographical area within a State where the user is located.	The syntax and value are to be defined by the considered ANSP. The table associating such an organisation-name to each ICAO location indicator (4 characters) needs to be registered and published by ICAO.
Organisational-unit-name (OU1)	OU1 = the ICAO location indicator (4 characters) of the considered user;	
Common-name (CN)	CN = the 8-letter AF-address (or AFTN indicator) of the considered user, irrespective of whether it is a direct or indirect user.	

Table 3: AFI AMHS Addressing Plan

3.2.5.2 Distribution lists.

3.2.5.2.1 The scheme to be used for the identification of AMHS Distribution Lists is the same as for potential AMHS users.

3.2.5.2.2 The O and OU attributes would then represent the expansion point of the distribution list.

3.2.5.3 Indirect AMHS users

3.2.5.3.1 AFI AMHS Addressing Scheme shall be applicable to both direct and indirect users in the AFI Region as soon as the scheme is published. This scheme should be published through ICAO and other appropriate bodies (e.g. the ECAC community or EUROCONTROL Member States). AFI users should use the XF-address of users outside the AFI Region until another addressing scheme (CAAS) is published by the organisations responsible for those users.

3.2.5.3.2 As soon as all ANSPs have published their addressing scheme (CAAS), there would be no more need for AFI ANSPs to support XF-addresses for users within the AFI Region.

3.2.5.4 AFI AMHS Addressing Plan Database

3.2.5.4.1 It consists of the creation of a new table ("AFI_AMHS_Addressing_Plan" table) in a separate Access file ("AFI_AMHS_Addressing_Plan.mdb") with the following fields:

1. *'Country_ Name' field* = the value "XX".
2. *'ADMD' field* = the value "ICAO".
3. *'PRMD' field* = one of the following values: "Aena", "Germany", "CFMU", "EG", "France", ... Values are collected in [13].
4. *'Organisation_Name' field* = This attribute contains the name of the geographical location of the AMHS user in terms of REGION concept. Values are defined on a local basis. An input from different AFI ANSPs is needed in order to associate each internal location indicator with the REGION. Values are collected in [13].
5. *'Organisational_Unit_1' field* = This attribute contains the name of the geographical sublocation of the AMHS user within its respective geographical location.
6. *'Common_Name' field* = This attribute contains the name or identification of the computer application or distribution list.

3.2.6 Guidelines on PRMD Name assignment

3.2.6.1 Purpose

3.2.6.1.1 A PRMD-name attribute shall be formulated and assigned by each ANSP in order to uniquely identify the AMHS Management Domain of which the considered ANSP is in charge. Practically, the PRMD-name attribute identifies that part of the AMHS for which an ANSP is responsible.

3.2.6.2 Assignment rules

3.2.6.2.1 When assigning a value to the PRMD-name attribute the following rules should be considered:

1. It should be representative of the whole AMHS Management Domain for which the ANSP is responsible;

2. It should be as short as possible, an acronym would be sufficient;

Note. – The use of the two-letter ISO 3166 country codes (e.g. FR for France, AU for Australia, US for the United States, etc.) is not advisable, as these codes are used as values of the Country-name attribute and not the PRMD-name attribute. This may confuse the operators.

3. It should be stable and not subject to changes unless there are duly justified technical and/or operational reasons;

4. It should be unique and unambiguous;

Note. – Care should be taken not to use a name or an acronym such as "civil aviation", "ANSP", "DGAC".

5. A default value has been reserved in order to ensure that this attribute value is always defined. This default value is the ICAO two letter State/territory identifier, as may be found in Doc 7910 [7].

6. It should only comprise standard characters, e.g. no accented letters or letters only used in specific geographical areas;

7. The use of figures is not advisable.

3.2.6.3 Registration

3.2.6.3.1 Once assigned by the concerned ANSP, the PRMD-name value(s) shall be registered and published by ICAO after checking its uniqueness, as described in paragraph 3.2.6.2.

Note. – ICAO being the naming authority for AMHS addresses, there is no requirement to register the PRMD-name value(s) with a national authority.

3.2.7 Guidelines on Organisation Name assignment

3.2.7.1 Purpose

3.2.7.1.1 The purpose of the Organisation-name attribute is to allow each ANSP to split, if needed, the AMHS Management Domain (MD) for which it is responsible in distinct geographical areas.

3.2.7.1.2 Within a given AMHS Management Domain (identified by the "C", "A" and "P" attributes) two potential AMHS network architectures are possible:

1. centralised architecture, with one single ATS message server; and

2. geographically distributed architecture, with several regional ATS message servers.

3.2.7.1.3 It is to be noted that architectural aspects and addressing aspects are not completely linked together, in effect the agreed addressing scheme does not place any constraints on the AMHS network deployment plan.

Both types of architecture have advantages and drawbacks, as summarised in the following Table 5.

	Centralised architecture	**Distributed architecture**
Applicability	Relatively small MD; Relatively small number of users.	Large MD; Large number of users.
Advantages	Easy management (one server).	A high quality of service can be offered to the users; Each server is dimensioned to match the requirements of the users attached to it; Allows a better load sharing on the network.
Drawbacks	Require a high grade of service from the network (e.g. in terms of availability, end-to-end throughput, etc.)	A highly distributed architecture may increase the complexity of the management of addresses by operational staff.

Table 4: Centralised AMHS architecture versus distributed AMHS architecture

3.2.7.2 Assignment rules

3.2.7.2.1 Before assigning a value to the Organisation-name attribute, each ANSP should follow the following 3-step process:

1. Develop the general architecture of the AMHS to be implemented;

2. Define the location and the number of sites at which ATS Message Server could be installed within a foreseeable time frame (e.g. 5, 10 or 15 years); and

3. Chose and assign a name to each one of these sites.

3.2.7.2.2 A specific case is the situation where a single ATS Message Server is implemented in an AMHS MD, providing services to AMHS users that are all directly attached to this server (centralised architecture). For simplification, it is suggested that a single organisation- name (O) value be allocated to all location indicators in the AMHS MD.

3.2.7.2.3 Potential criteria for the selection of sites include:

Geographic divisions, such as: North, South, East, West,

etc.;

Administrative divisions of the concerned ANSP, such as ATS, Meteorological,

etc.; Operational divisions centred around the ACCs (if more than one ACCs exist);

Operational divisions centred around the main airports;

Mapping of the AMHS architecture on the existing AFTN/CIDIN architecture;

A mixture of the above criteria; and
Other.

Note. – Care should be taken not to define too many geographical areas within a given AMHS MD as this may lead to less efficient message routing.

3.2.7.2.4 When assigning a value to the Organisation-name attribute, the following rules should be considered:

1. It should be as short as possible;
2. It should only comprise standard characters, i.e. no accented letters or letters only used in specific geographical areas;
3. The use of figures is not advisable.

Note. – An ANSP should define different values for the Organisation-name attribute only if it plans to implement a distributed AMHS architecture in the short, medium or long term future. ANSPs not planning to implement a distributed AMHS architecture should allocate a single value for this attribute.

3.2.7.3 Registration

3.2.7.3.1 Once assigned by the concerned ANSP, the Organisation-name values shall be registered and published by ICAO, as described in paragraph 3.2.8.3.

Note. – ICAO being the registration authority for AMHS addresses, there is no requirement to register the Organisation-name value(s) with a national authority.

3.2.8 Address conversion

3.2.8.1 Addressing Plans requirements

3.2.8.1.1 The selected address conversion strategy must take into account the following principles:

The selected address conversion solution shall be able to support any X.400 addressing plan making use of any address form.

The AFTN address of an AFTN or AMHS user is unambiguous, internationally recognised and shall not be replaced by another value.

3.2.8.1.2 The addresses to be considered are: AFTN, XF-form, CAAS and MF (non-CAAS). It can be concluded that:

All AFI AFTN/AMHS gateways shall implement the conversions AFTN<=>XF;

All AFI AFTN/AMHS gateways shall implement the conversions AFTN<=>ANSPs;

All AFI ANSPs gateways should implement the conversions AFTN<=>ANSPs, together with an ANSPs address space within their remit (technical specifications recommendation);

To deal with the arrival of spurious XF addresses at AFI ANSPs MDs from the global AMHS, the redirection XF=> ANSPs could be supported by all ANSPs;

If an ANSP defined an MF (non-ANSP) address space, then all gateways would have to support the conversion AFTN<=> MF (non-ANSP). This is an undesirable alternative since a global and common CAAS has been recommended by ICAO.

3.2.8.2 Address Conversion Scenarios and Criteria

3.2.8.2.1 The identified scenarios are the following: single conversion, AMHS transit conversion, AFTN transit conversion and multiple transit conversion.

3.2.8.2.2 Once the scenarios have been established, the following considerations for the address conversion have to be performed:

The result of the address conversion performed in an AFTN/AMHS gateway shall depend only on the pre-defined pair of unambiguously associated AFTN and AMHS addresses, and not on the gateway itself, according to the form published by ICAO and defined by the delivering MD.

It is recommended that each gateway performing address conversion should have access to the minimal necessary information to perform mappings between AFTN addresses and AMHS addresses and vice-versa. The complete mappings between AFTN addresses and their AMHS equivalents should be published (in electronic form) and made available to all gateways that support address translations.

The conversion process shall be easy to use and manage, and efficient.

3.2.8.2.3 As a conclusion, a compromise solution combining the use of algorithmic tables and X.500 directory is preferred for the address conversion.

3.2.8.3 General model for address distribution and gateway address conversion

3.2.8.3.1 A model of address distribution and gateway address conversion is depicted in Figure 1 below. The figure represents information exchanges between ICAO and three ANSPs implementing AMHS Gateways, concerning address conversion. ANSP1 and ANSP2 implement a distributed address publishing service (APS), e.g. by means of ATN X.500 Directory Services. This allows electronic distribution. ANSP3 provides this information to ICAO for manual collation and distribution (e.g. on paper, electronic database), and does not support a directory.

The dotted arrows represent exchanges that are performed in a non-electronic way, e.g. through "paper" procedural exchanges. The full arrows represent exchanges that are performed electronically using appropriate communication protocols.

3.2.8.3.2 The model identifies a number of components that are necessary for address conversion:

1) Collection and distribution of the basic addressing information that establishes equivalence between the different addresses identifying each AMHS and AFTN user; the content of this information **must** be standardised and made available to all AFTN/AMHS Gateways;

2) Access to, and/or import of the basic addressing information into AFTN/AMHS gateways. This depends on the particular gateway implementation;

3) Re-structuring the basic addressing information into a format suitable for use by each gateway's internal address conversion procedures (AMI). This is again gateway implementation specific;

4) The internal procedures and data structures of the gateway (AMP and AMT) that make use of the re-structured addressing information. This is gateway implementation specific.

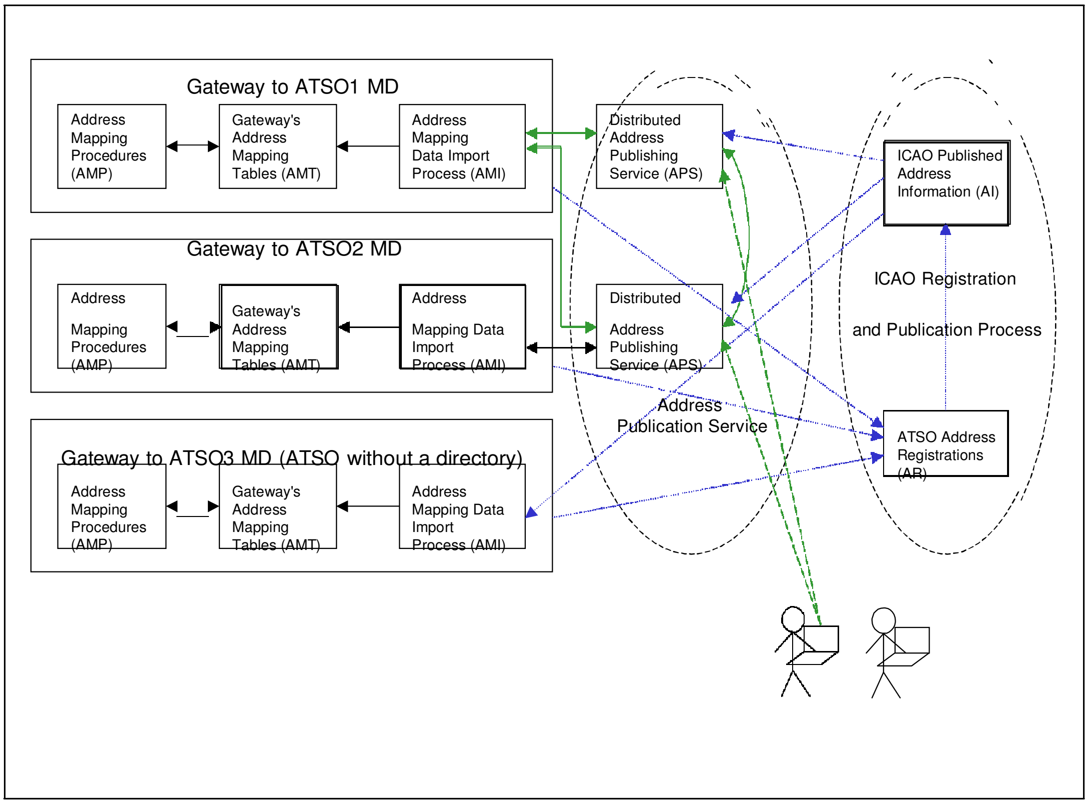

Figure 1: General model for gateway address conversion

3.2.8.3.3 The address mapping information content held in AMT and distributed through APS is identical in nature.

3.2.8.3.4 The structure of APS must be compatible with many different systems (e.g. different ANSP's Gateways), and must therefore be standardised. There are a number of possibilities for structuring APS:

As an X.500 Directory Information Tree, thereby enabling implementation of a Distributed APS;

By some other electronic means (e.g. CSV files);

On paper.

3.2.8.4 The impact of different paths through the AFTN and AMHS

3.2.8.4.1 There is also a potential need for messages to undergo multiple address conversions. In order to minimise message rejection and to regulate the responsibilities for conversions, the following rules should apply:

Originating MDs (for originator's addresses) shall generate addresses according to the form published by ICAO and defined by the delivering MD (for recipient addresses);

Delivering MDs shall be authorised to reject messages received with recipient addresses which do not comply with the address form published by ICAO and defined by the delivering MD;

Delivering MDs should have the capability of redirecting potential internal XF addresses to the corresponding MF(S) form addresses for use within their delivering MD, for a transition period of at least 6 months after publication of the appropriate ICAO documentation;

Transit domains should not attempt to perform any AMHS <-> AMHS mapping unless a specific bilateral agreement has been established with the delivering MD (for recipient's addresses) or the originating MD (for originator addresses). Transit MD should only use the attributes C, A, P (which are invariant and predetermined for all AMHS address forms in the ATS) in selecting a message route.

3.2.8.5 Recommended AMHS Address Conversion Strategy

3.2.8.5.1 The recommended AMHS address conversion strategy is the means by which the general model represented in Figure 2 should be realised by States in the AFI Region. It is also applicable on a worldwide basis and has been presented and adopted by the ICAO ATNP as the general AMHS address conversion strategy. This strategy is made of the following elements:

1) the establishment, by an appropriate ICAO body or entity, of an ICAO Registration and Publication process as a set of procedures for collecting and publishing AMHS address conversion information on a periodic basis (e.g. twice yearly). This will

include:

a) the MD information included in the ICAO Registry of AMHS Management Domains, i.e. the MD identifier and the corresponding ICAO State/territory two letter identifier, together with the specification of the type of implemented addressing scheme (XF or CAAS);

b) for those MDs having implemented the CAAS, the mapping information providing the organisation-name address attribute for each ICAO location indicator;

2) a Distributed Address Publishing Service (APS), based on ATN Directory Services, that allows publication of real-time AMHS address conversion information. This is to be implemented at the earliest opportunity upon ANSPs initiative, with the following principles:

a) use of the directory scheme;

b) initial population of the Directory Information Base with the information distributed through the ICAO Registration and Publication process;

c) implementation of a single Directory System Agent (DSA) per ANSP to hold the MD Registry sub-tree, the world-wide ANSP information distributed through the ICAO Registration and Publication process, and the local AMHS MD address conversion information sub-tree; and

3) in co-existence with the use of Address Mapping Tables (AMT) directly derived from the information published through the ICAO Registration and Publication process, for ANSPs that choose to defer the implementation of ATN Directory Services.

3.2.8.5.2 As a local implementation matter, ANSPs that envisage implementation of Directory Services for the purpose of the Distributed address publication service (APS) at the same time as they implement AMHS, should also consider the use of directory solutions as a technical option for the gateway's address mapping tables (AMT).

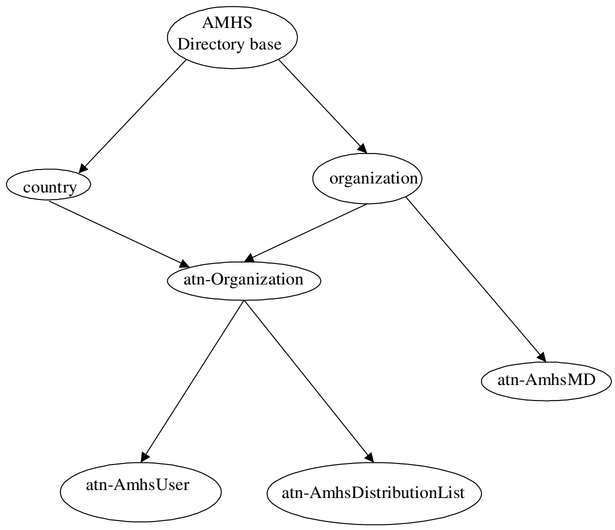

Figure 2: DIT structure for AMHS address conversion

3.2.8.6 Regional provisions

3.2.8.6.1 The strategy above is complemented by the following transitional provisions which may apply regionally.

3.2.8.6.2 In case the first element in the above strategy is not implemented by ICAO in a timeframe compatible with early AMHS implementations, an equivalent process may be set up on an ad-hoc basis among ANSPs forming an AMHS island. This is particularly applicable to any AFI ANSPs being early AMHS implementers.

3.2.8.6.3 In case of ANSPs implementing the second element in the above strategy that initially prefer to group together for the implementation of a single ICAO Regional DSA, the following should apply:

the MD Registry sub-tree;

a local AMHS MD ANSPs information sub-tree for each of the ANSPs in the group;

and the world-wide ANSPs information distributed through the ICAO Registration and Publication process.

3.2.8.6.4 The Regional DSA thereby becomes an aggregation of the local DSAs envisaged in the principle strategy.

3.2.8.6.5 In the AFI Region, the creation of an Offline Management Centre is recommended to consolidate, co-ordinate and distribute AMHS user address changes across the Region. This Offline Management Centre should implement such a Regional DSA in support of its address management activities.

3.3 AMHS topology

3.3.1 General potential AMHS topologies

3.3.1.1 As for any other network topology, an AMHS topology describes the connectivity among the nodes - which are in this case AMHS COM Centres – and links – which are AMHS logical connections at the ISO/OSI application layer.

3.3.1.2 From a theoretical viewpoint, there are many possible solutions for a network topology. Each of the chosen designs has distinct properties in terms of cost, transit time (number of hops to be passed), routing complexity, reliability (survivability). Furthermore, from a more practical perspective, a network topology is also often related to the organisation and relationships between its users, and possibly network managers. In a situation where traffic flows are not equally distributed between nodes (from a statistical perspective), the traffic patterns have also a great influence on designed topologies.

3.3.1.3 General network topologies include:

Tree-shaped topologies, including

- o Star,
- o String,

Partially meshed topologies, including

- o Double star (two interconnected stars centered on two distinct "hubs"),
- o Ring,
- o Hyper-ring (two rings with several links interconnecting them),

Hybrid topologies, e.g. using a partial mesh backbone between some nodes and star from the backbone nodes to other nodes,

Full meshed topology.

3.3.1.4 A general analysis of such topologies, based on the properties listed above, is provided in the following.

3.3.1.5 Reliability, transit time, cost and operational complexity are all factors affected by the topology of a network. Table 6 summarises the characteristics of the topological structures addressed above in order to indicate the advantages of certain topologies over others.

3.3.1.6 In Table 6 measures are used to evaluate the technical merit of a topological structure: Number of links, maximum number of hops, complexity and reliability. Each of these measures is described below.

3.3.1.7 A low *number of links* per node for a design will often be associated with low cost. Vice versa, a higher link-per-node ratio indicates a more expensive network topology. The tree shaped topologies (star, string) have the lowest number of links per node. Ring and hyper-ring architectures have a small number of links per node. At the opposite end from the tree structures, the full mesh network marks the upper limit of the link-per-node ratio.

3.3.1.8 Clearly, a smaller number of *hops* from a source node to a destination node will result in shorter transit times. Here, a full meshed topology is the most desirable. The star topologies, with their very small number of hops, are also very desirable. On the other hand, string and simple ring architectures can have a significantly greater numbers of hops. – A large number of hops is associated with a large number of intermediate nodes and links which have to be dimensioned for conveyance of transit traffic. The related capacity enhancements also constitute a cost factor.

3.3.1.9 *Complexity* provides here a measure for the effort to be spent on network design, establishment of appropriate (re-)routing mechanisms and network operations. The number of potential paths between nodes, as well as the need to sum up multihop traffic (in order to get capacity figures for nodes and links), increase the complexity of the network design task. The complexity for re-routing of traffic increases also with the number of candidate links providing alternative paths between each pair of nodes. Finally, the effort for network management and maintenance grows with the number of links providing connectivity between a given set of nodes. Centralised (star) topologies are easier to maintain than those that are highly distributed (as meshed structure).

3.3.1.10 The *reliability* of a network increases with the number of established links allowing alternative paths in case of link failures (provision of adaptive routing assumed). More precisely, if *n* represents the minimum number of nodes to which any node is connected (*n*-connectivity) then we can expect that the probability that a given node has access to at least one of its neighbours increases with the quantity of *n*. A partial mesh topology has 2-connectivity or greater, a full mesh offers as upper limit a (N-1) connectivity (where N represents the number of nodes).

Topology	Number of Links	Relative Number of Links	Max Hop Count	Complexity	Reliability
Star (tree)	N-1	Lowest	2	Lowest	Lowest
Double Star	2 (N-2)+1	Low	2	Low	High at core, low at remote locations
String (tree)	N-1	Lowest	N-2		
Ring	N	Low	(N-1)/2	Low	Moderate
Hyper-Ring	2 N	Low	2	Low	Moderate

Topology	Number of Links	Relative Number of Links	Max Hop Count	Complexity	Reliability
Partial mesh	Moderate	Moderate		High	Good
Full mesh	[N*(N-1)]/2	Highest	1	High	Highest

Table 5: Comparison of alternative network topologies

3.3.2 Design elements for the AFI AMHS

3.3.2.1 In application of the principles above, the following elements have been taken into account for the definition of the AFI AMHS topology:

1. Quality of service (Transit delays),
2. Quality of service (Availability / Reliability),
3. Cost effectiveness,
4. Complexity of operation,
5. Responsibility for transit traffic.

3.3.2.2 Most of these criteria were already defined as the main considerations for AFTN topology design (ref. ICAO Doc 8259-AN/936/1991 [9].

3.3.3 Possible approaches for the AFI AMHS topology

3.3.3.1 SPACE recommendation for a fully-meshed topology

3.3.3.1.1 The objective of ensuring transit delays compatible with the QoS performance requirements specified in section 3.1.4 led to the SPACE recommendation of a **fully-meshed topology for the AMHS network deployed in the AFI Region**, thereby minimising the number of hops between any pair of International MTAs / ATS Message Servers in this area (ref. [16] and SPACE WP321 Report "AMHS Extensibility Principles").

3.3.3.1.2 The end-to-end transit delay in networks is mainly caused by the processing time in the nodes passed by a message and the transmission times on the links between these nodes. With given processing times, link speed, average message length and protocol overhead a first estimation of the number of allowable hops for a given maximum end-to-end transit delay is possible. – For a link speed of 256 kbps five hops are allowed in the international network to meet the maximum end-to-end transit delay for the high QoS class. With 64 kbps only two hops are allowed (ref. [16] and [21]).

3.3.3.1.3 To be realistic, such a recommendation implies that an underlying network forming a common lower layer infrastructure would be available across the considered geographical area. The requirements placed upon such an underlying network are described in section 3.5.

3.3.3.1.4 This approach favours criteria 1 (QoS – transit delays) and 2 (QoS – availability) among those listed in section 3.3.2. No other topology could rate better than a fully-meshed network regarding these objectives.

3.3.3.1.5 As far as criteria 3 (cost effectiveness) and 4 (complexity of operation), it may be considered that the need to establish and maintain AMHS connections with any other International ATS Message Server in the AFI network represents a non-optimised cost (in network capacity and required staff). However, although parallel operations have to be performed with all communication partners in such a network topology, the similarity between these operations reduces complexity and increases efficiency, thereby reducing the negative impact on costs.

3.3.3.1.6 Complexity of operation, although obviously higher that in a tree-shaped network, is probably lower than in some partially-meshed topologies where network behaviour, required tasks and diagnostics vary depending on the existence or not of a direct link between both MTAs.

3.3.3.1.7 The factor of responsibility of transit traffic (criterion 5) should also be considered. In the fully meshed topology each MTA is managing its own traffic with no transit traffic coming from other international MTAs (except re-routing), representing a clear advantage in comparison with other topologies.

3.3.3.1.8 It must be noted that an AMHS fully-meshed topology could lead to approximately 50 AMHS connections to/from each COM centre, when AMHS is fully deployed in the AFI Region, based on the current number of international COM Centres. This is significantly different from the current CIDIN AFTN topology in Europe, which is a partially-meshed network with a maximum of 12 connections (AFTN and/or CIDIN) from a COM Centre to its adjacent Centres. Appendix A to the ATS Messaging Management Manual [12] specifies how transition may take place from the current CIDIN connectivity and topology to a fully meshed AMHS network.

3.3.3.2 CFMU approach for a hybrid topology

3.3.3.2.1 The CFMU is in a specific situation as a EUR Facility, which is an end- user of communication flows, rather than a COM Centre like other parties in the international AFTN/ CIDIN/ AMHS network. The organisation of the CFMU in two Centres also creates specific requirements.

3.3.3.2.2 Because of the significant change between the current CIDIN topology and a fully-meshed network, and due to specific operational requirements related to CFMU contingency (see AFSG/PG31 WP08, “Considerations in the integration of CFMU in the AMHS network”, Roma, March 2008), CFMU favours for AMHS a hybrid topology similar to the current CIDIN connectivity:

A double-star to six adjacent COM Centres, through which CFMU traffic is relayed to other communication partners;

The existing AFTN/CIDIN topology between these six COM Centres and other COM

Centres in Europe when the traffic flow is originated/directed to a State “beyond” those of the six COM Centres.

3.3.3.2.3 Such a topology could be revisited when more experience is gained in AMHS operation, and depending upon the availability of some automatic re-routing capabilities. Based on such conditions a more complete level of meshing could be envisaged. Such an approach clearly favours criteria 2 (availability) and 4, in order to reduce complexity of operation.

3.3.3.3 Approach favouring cost effectiveness

3.3.3.3.1 Based on the estimation that cost reductions could be obtained if only a partially-meshed topology is implemented, some States have expressed their intention to limit the establishment of direct links from their international MTA to the international MTAs in other States with which they have a given volume of traffic, or specific connectivity requirements.

3.3.3.3.2 In this approach favouring criterion 3 (cost effectiveness), the goal is to reduce the workload and cost of operation, including configuration, testing and in service support.

Initial system configuration,

Interoperability testing,

Transition activity,

In service support, including fault management,

Re-testing when MTAs are changed and/or upgraded.

3.3.3.3.3 Whilst the intent to minimise operation costs is obviously a valid objective, this should not be detrimental to the overall quality of service and to the (partly contradictory) objective to minimise the number of hops in the network. Furthermore it may also be considered that when a certain number of AMHS connections is established from a COM Centre, and a high AMHS operational experience is available in that COM Centre, then the establishment of an additional connection to another COM Centre increases only marginally the cost of operation.

3.3.3.4 Influence of the current AFTN/CIDIN topology

3.3.3.4.1 This subject has been partly and/or indirectly addressed in the sections above.

3.3.3.4.2 With the assumption that approximately 50 States are part of the Eur Region, a fully-meshed AMHS network when AMHS is available is all of these States will also represent approximately 50 direct AMHS connections (international MTA to MTA associations) to/from each COM Centre. This number is to be compared to the current number of (intra-Europe) international connections to/from an international COM centre, which is between three and twelve links before migration to AMHS.

3.3.3.4.3 If transition was to take place quickly (e.g. between a few months and one or two years) from the pre-AMHS situation to such a fully-meshed topology, the effort would indeed be considerable and the target would be difficult to achieve. However, it is recognised that the transition to AMHS at the AFI scale will be progressive and may take a number of years.

3.3.4 Recommended AFI AMHS topology

3.3.4.1 The objective of this section is to specify a AFI AMHS topology which meets the various objectives expressed in section 3.3.3, taking into account the fact that they are sometimes contradictory.

3.3.4.2 The general principle adopted is that the expected quality of service, in terms of transit times and availability (criteria 1 and 2) should be maintained to define the target topology.

3.3.4.3 This leads to confirm that **the AMHS topology in AFI should be fully-meshed, as a long-term objective**. However, it should also be recognised that:

there is a pre-requisite to the implementation of such a topology, which is the availability of a seamless underlying network across the considered geographical area;

during the transition to this target topology, a partially-meshed network following the constraints of the various ANSPs and participants to the AFI AMHS network.

3.3.4.4 Principles need to be established for the transition phase, so that a clear direction is provided to ANSPs implementing AMHS in their COM Centres.

3.3.4.5 These principles are the following:

1. until a common underlying network at a AFI scale is available, the implemented AMHS topology should:

    a. **at least replicate the former AFTN topology**;

    b. in areas where a common underlying network is already available but for a smaller area than AFIope (e.g. multi-States, or “sub-Regional”), **implement a fully-meshed AMHS island, with at least two entry points** into the island;

2. when a common underlying network at a AFI scale is available, and while transition to the fully-meshed target is in progress, the topology should be such that:

    a. **no more than two hops are needed for communication between any two International MTAs** in the considered area;

    b. **Two distinct paths are available at AMHS level** for communication between any two International MTAs.

3.3.4.6 The transitional partially-meshed topology specified in item 2 above can be achieved, for example, by the establishment of several partly overlapping fully-meshed AMHS islands:

each pair of AMHS islands must have a non-empty intersection, with at least two “multi-island” AMHS COM Centres;

the central facilities (e.g. CFMU, EAD, etc.) must form a fully meshed island with the "multi-island" AMHS COM Centres.

3.3.4.8 In line with the numerical requirements for QoS adopted in section 3.1.4, the strategy for AMHS topology may be reviewed on the basis of compiled AMHS operational experience, when a common underlying network at a AFI scale is available and a significant number of AMHS COM Centres are in operation.

3.4 Routing mechanisms

3.4.1 Available routing mechanisms

3.4.1.1 AMHS uses the routing mechanisms of its X.400 base standards. X.400 routing is static by nature, it uses the address attributes forming O/R addresses to determine the next hop towards which the message must be routed:

local delivery,

AFTN/AMHS gateway (MTCU), or

adjacent MTA inside the AMHS Management Domain of the current MTA,

adjacent MTA in a different AMHS Management Domain.

3.4.1.2 Conceptually, X.400 routing tables are made of records associating a potential combination of address attribute values to a next hop. For each message, the route record with the best match for each AMHS recipient's address attributes is looked for in the routing table, to determine where the message is to be routed. In case of a message with multiple recipients and different routes, the message is "expanded" or "split" into several messages, according to the various destinations.

3.4.1.3 This section focuses on international AMHS routing, i.e. inter-domain routing.

3.4.1.4 Unlike in AFTN, where any substring from 1 to 7 characters may be used to determine a route, X.400 address attribute values are generally considered "as a whole" when looking for a best match. Some X.400 implementations may implement substring matching but this is not a standard feature.

3.4.1.5 Inter-domain routing, from an international MTA in an AMHS MD to an international MTA in another AMHS MD, should therefore use only entire address attribute values. The attributes Country-name, ADMD-name, PRMD-name and potentially Organization-name, usually represented by their initials C, A, P and O are sufficient for Inter-domain routing. Organization-name must be used only in specific cases, when destinations are located in AMHS MDs with multiple International MTAs, and having implemented the CAAS Addressing Scheme.

3.4.1.6 It may be noted that ISO/IEC 10021-10 (2003) [23], which is aligned on ITU-T Recommendation X.412 (1999), "INFORMATION TECHNOLOGY – MESSAGE HANDLING SYSTEMS (MHS) – MHS ROUTING" describes an X.400/MHS Routing functionality based on Directory Services. There is no requirement to implement this feature in AMHS, including when the Extended ATS Message Handling Service is deployed.

3.4.2 X.400 re-routing mechanisms

3.4.2.1 Based on the general routing principles described above, re-routing consists in the definition of an alternative route to the intended destination, if for any reason there is a transfer-failure or delivery-failure to the initially determined next hop.

3.4.2.2 Re-routing may be either manual or automatic. In the first case, the MTA operator, in view of the transfer-failures, modifies temporarily (or definitively) the routing tables to specify an alternative next hop. The main requirements placed on the software by manual re-routing are related to:

the ease of reconfiguration;

the immediate applicability of the modification: it is preferable that the routing be modifiable on line, or require only a fast restart or parameter load.

3.4.2.3 Regarding automatic re-routing, although not prevented by the X.400 base standards, nor by the way they are designed, this feature was initially not a standard practice in X.400 products. The main reasons were the following:

1. MHS/X.400 was initially designed for messaging traffic with relatively low transfer time requirements, clearly non-real time, where it was possible to “wait” for the availability of a connection to the intended MTA, in case such a connection was not immediately available;

2. In this context, the usual practice in the store-and-forward MHS/X.400 is to store a message, and, in case of transfer failure to the next MTA, to perform a pre-defined number of “retry” towards this same MTA (based on timers), before a non-delivery-report is sent back to the message-originator (or to the originating-MTA).

3.4.2.4 However, due to the adoption of X.400 by communities with more stringent transfer time and availability requirements (Defence, Air Traffic Services), it should be possible to obtain from X.400 software manufacturers automatic re-routing mechanisms.

3.4.2.5 The principle of such re-routing would be that, after the number of retries to the main route to the next MTA, an alternative route already specified in the routing table would be used. It is important that those responsible for system operation be aware that this re-routing facility is activated.

3.4.2.6 Care should be taken about a possible interaction with X.400 timers when such a mechanism is used. For example, if no alternative route is specified, a MTA will retry to transfer until the expiry the MTA and MTS timers, before a NDR is generated. If an alternative route is defined, then a time allocation should be kept to use the alternative route before the timers expire. This should be considered in conjunction with the re-routing mechanisms at the underlying network level: timers and re-routing mechanisms at the underlying network level have to be shorter than timers and re-routing mechanisms at the AMHS level. The reason for this is that most of the time the unavailability of a P1 association is going to be caused by a transitional problem in the underlying network.

3.4.3 Routing in the recommended AFI AMHS topology

3.4.3.1 In the fully-meshed target topology, routing is trivial as there is a direct route from any International MTA to any other International MTA in the AFI AMHS network.

3.4.3.2 Transfer failures could be caused by unavailability of underlying network (that have their own resources to recover the failure, out of AMHS procedures) or by the failure of the destination MTA itself. In such a situation re-routing does not improve quality of service, but simply overloads the AMHS network by moving the problem from place to place. Depending on the underlying network and on the operator capability (e.g. depending upon the management tools and information available to him/her) to determine the reason of a failure, manual re-routing may however have benefit in some cases.

3.4.3.3 Automatic or manual re-routing is required, however, for efficient handling of AMHS traffic to other ICAO Regions (see next section).

3.4.3.4 In the temporary partially-meshed topology, the next hop for each destination MTA is either of the following:

1. the destination MTA itself, if a direct connection/route exists, or
2. an intermediate MTA which has a direct connection to the destination MTA.

3.4.3.5 The first case is identical to the situation of a fully-meshed AMHS network, where automatic re-routing is not really useful but manual re-routing may have some value, if an accurate fault diagnosis can be established.

3.4.3.6 In the second case, the availability of two distinct paths established as a design principle enables to use manual or automatic re-routing at AMHS level. Use of re-routing is essential in this situation, and automatic re-routing should be preferred whenever as it is available. This allows to make sure that the failure of an international MTA (e.g. in one of the multi-island AMHS COM Centres, in the depicted example) does not cause loss of communication between two islands.

3.4.3.7 Therefore, in the partially meshed network, it is recommended that:

1. one single route be specified in the AMHS routing tables if a direct connection exists,
2. a main route and an alternate route be specified in the AMHS routing tables if no direct connection exists and a two hops path is required between the considered MTA and the destination MTA.

3.4.4 Routing to/from other ICAO Regions

3.4.4.1 For message flows incoming to or outgoing from the AFI Region, the routing strategy is to route messages from/to one of the Regional boundary ATS Message Servers to/from the international MTA of the destination/source AFI AMHS MD, using either a single direct route if existing, or one of the main/alternate routes in case a two hops path is available between these MTAs.

3.4.4.2 The assumption is that, in the target environment, these Regional boundary ATS

Message Servers would be implemented by States or ANSPs that already provide Regional boundary AFTN/CIDIN COM centres towards other ICAO Regions.

3.4.4.3 For resilience purposes, a minimal number of two inter-Regional boundary MTAs needs to be implemented to connect to each other ICAO Region. To gain full benefit of this duplication, automatic or manual re-routing is required, so that alternate routing via the "alternative" MTA can be activated in case of loss of connectivity with the "main" boundary MTA to be used.

3.4.4.4 The "alternative" MTA can be connected with the same MTA in the other ICAO Region, as the "main" MTA, or preferably it can also be connected with an alternative MTA in the other ICAO Region.

3.5 Underlying network

3.5.1 Background

3.5.1.1 In terms of the ISO/OSI seven layer model, AMHS resides in the application layer. The design of such an application is dictated by both the end users, who best know their particular needs, and by the state of the art technological environment, which determines the way in which these needs are transformed to concrete technical specifications. The current situation, the way of migrating from this situation to the targeted future, the process flow, the safety requirements, the security requirements, the quality of service requirements and the expected results are all translated into the application specification. These requirements not only affect the design of the application but their influence permeates to the lower layers.

3.5.1.2 Therefore, the creation of an appropriate underlying network is seen as essential for the smooth deployment of AMHS.

3.5.2 General principles

3.5.2.1 In current communications practices, the independency between application and network levels is highly desirable.

3.5.2.2 The separation of application and network brings several benefits:

the provision, development and management of the network and AMHS can proceed largely independently (provided sufficient capacity is available within the network), leaving each discipline free to concentrate on its particular sphere of competence,

there are economies of scale to be gained by the sharing of the network between multiple applications, resulting in better utilisation of resources,

the increased size of the network (over a purely AMHS network) should deliver a better quality of service and in particular a more robust infrastructure,

routing, at the AMHS level, is independent of the lower level network and in particular any AFI International ATS Message Server is directly accessible by any other.

3.5.2.3 The logical connection (links) of the AMHS topology implemented by means of a transport service could make use of the physical connectivity provided by a layer-3 network infrastructure.

3.5.2.4 The following Figure 4 illustrates the relationship between logical and physical connectivity for the international AMHS. Each international COM centre will accesses the underlying network over the local network node through a network access line.

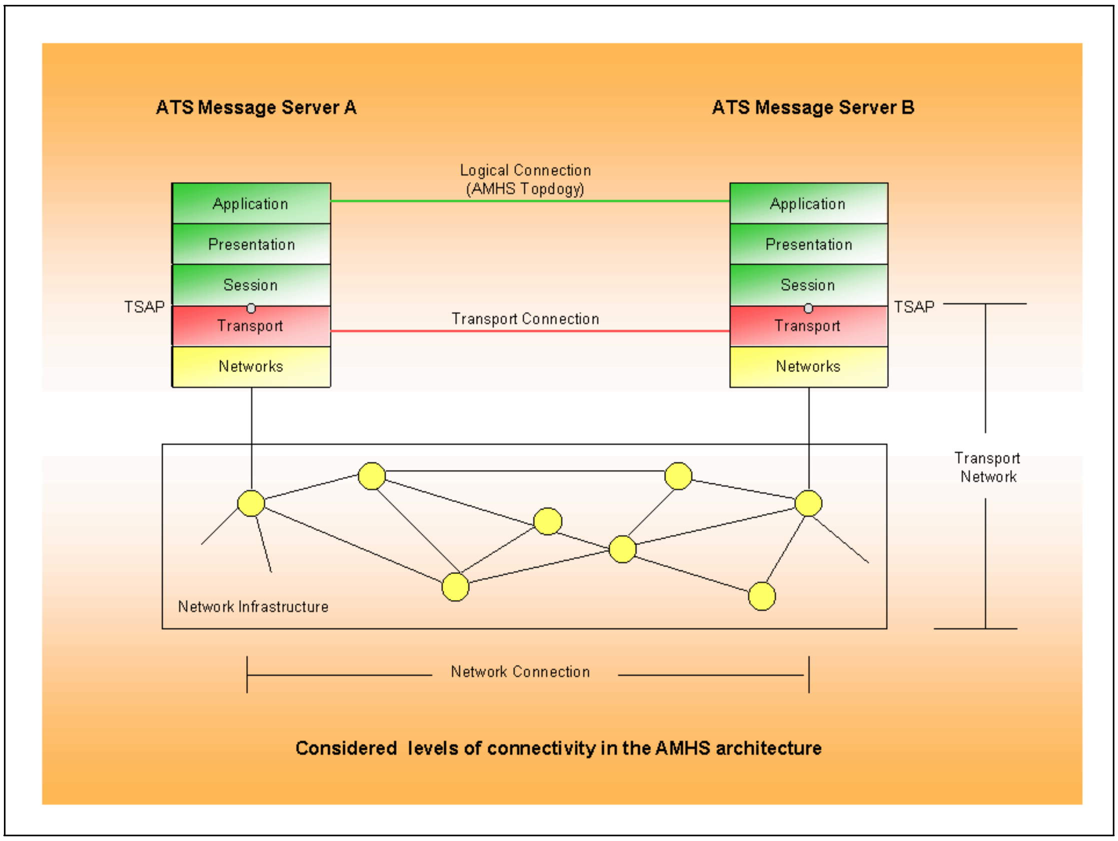

Figure 4: Logical and physical AMHS connectivity

3.5.3 Considerations

3.5.3.1 In the AFI area, a AFI wide TCP/IP based communications service dedicated to Air Traffic Management Communications is envisaged for supporting current and forthcoming applications.

3.5.3.2 This approach is supported by ANSPs' large experience in defining general principles (addressing, routing, …) and providing TCP/IP services for supporting ATC operational applications.

3.5.3.3 Furthermore, concerning international communications, ANSPs are acquiring expert knowledge about underlying network interoperability.

3.5.3.4 The AFI AMHS will be implemented according to the AFI implementation and strategy plans.

3.5.4 Conclusion

To be derived from the AFI Strategy and Implementation Plans.

Bilateral or multilateral connectivity arrangements should be made to accommodate initial AMHS operations, until such a common facility becomes available.

3.6 Interregional communication aspects

3.6.1 Guidance provided by ATNP on "AMHS over TCP/IP"

3.6.1.1 As a consequence of EANPG Conclusion 44/45, the ATNP provided guidance for implementation of "AMHS over TCP/IP" in 2002. Following the introduction of ATN/IPS SARPs through Amendment 83 to Annex 10 in 2008, these guidelines have been superseded by events, but they are **presented** hereunder **for historical purposes**.

1. It has been observed that some States or even Regions are implementing or planning to implement AMHS systems making use of lower communication layers that are not conformant to the ATN Internet Communication Services (ICS). Such AMHS systems conform to Doc 9705, Sub-Volume III, Chapter 1 (replaced with Amendment 83 by Doc 9880, Part II), with the exception of the clauses related to interfacing with ATN ICS. The most frequent occurrence of such non-compliant systems is related to AMHS systems making use of TCP/IP lower layers through a RFC1006 interface ("AMHS over TCP/IP").

2. Due to the store-and-forward nature of the AMHS, this can be done without compromising the end-to-end interoperability at the AMHS application layer with SARPs-compliant AMHS implementations, but at the cost of some dual-stack systems[4] for lower layers. Strict conformance to Doc 9705, Sub-Volume III, Chapter 1 is required, with the only exception of clause 3.1.2.2.2.1.2 ("Use of Transport Service"), to ensure such end-to-end interoperability.

3. The reasons invoked by States adopting such local policies include the following:

- The need for an immediate or short-term transition from existing ground networks, and in particular from X.25 networks that are reaching obsolescence;

- The use of a common ground network infrastructure shared with other ground applications, such as radar data distribution or inter-centre communications (such as OLDI in AFIope), such infrastructure being sometimes already in operation.

[4] Such dual-stack systems are beyond the baseline ATN architecture which is specified by ICAO.

4. It should be noted that in all known cases, the IP network used or planned to be used is a network infrastructure in which switching equipment and links are dedicated to ATS communications, building a so-called "private" IP network.

5. It is recognized that other transition strategies can also be developed, that make use of the proposed IP SNDCF to enable IP sub-networks to be used as ATN sub-networks, in a fully SARPs-compliant ATN ICS architecture. However such an architecture is not discussed in the present document.

6. Despite the fact that the implementation of "AMHS over TCP/IP" can meet, as described above, the specific objectives of a State on a local or regional basis, the attention of implementers should be drawn to the fact that the implementation of two different architectures has the following drawbacks:

- It limits "any-to-any" communication between AMHS systems on a global basis that could be needed in specific cases, e.g. for performance requirements;

- it requires the implementation by some States of "dual-stack" AMHS systems, to gateway between AMHS systems using the ATN ICS and AMHS systems using TCP/IP. This may reduce performance and availability;

- The cost of such gateway facilities is expected to be borne by States implementing non SARPs-compliant AMHS systems.

7. In view of the elements above, the following guidance is offered by the ATN Panel on the use of "AMHS over TCP/IP":

a) "AMHS over TCP/IP" implementations should not be presented as fully SARPs-compliant ATN implementations.

b) Non-SARPs-compliant "AMHS over TCP/IP" implementations are seen as a “local solution” within a State or Region. Inter-State or inter-Regional connections between such systems using TCP/IP should be subject to bilateral/regional agreements.

c) States or Regions that implement "AMHS over TCP/IP" systems within their domains are responsible for taking those necessary measures to ensure interoperability with SARPs-compliant implementations in other States or Regions.

d) Appropriate security measures should be taken when using an IP network, irrespective of whether AMHS uses TCP/IP directly or via the IP SNDCF.

8. The ATNP will continue to monitor related developments and will provide further guidance as appropriate.”

3.6.1.2 With introduction of the Internet Communications Service (see Doc 9880 – Part III [4]) the “AFI” solution “AMHS over TCP/IP” is now fully SARPs compliant.

4 AFI ATS Messaging Service Profile

4.1 Introduction

4.1.1 The detailed specifications for ATSMHS are currently spread over a number of different documents such as the ISO/IEC ISPs, ICAO SARPs and technical specifications (Annex 10 and Doc 9880) and the SPACE Final Report.

4.1.2 The AFI-ATSMHS Profile is intended to provide one single document that brings together these specifications by referencing the basic documents and by providing any additional specifications necessary for ATSMHS implementation in the AFI Region.

4.1.3 The scope of the Profile is limited to the specification of those aspects of systems that are involved in exchange ATS messages between international COM Centres. Other aspects, that involve gateways e.g. to the AFTN or communications that remain entirely within a State, are not dealt with in this Profile.

4.1.4 The first version of the AFI-ATSMHS profile was developed by AFI AMHS Taskforce Team.

4.2 AFI_ATSMHS Profile Objectives

4.2.1 The purpose of the Profile is to provide a single, relatively short specification containing interoperability requirements between international Message Transfer Agents (MTA).

4.2.2 Furthermore, the Profile contains the following requirements applicable within the AFI Region:

Use of TCP/IP for the underlying Data Communications Service;

Message Legal Recording;

Distribution Lists;

Use of IPM File Transfer Body Parts for the transfer of binary data (e.g. to support WMO BUFR coded messages);

Specifications of message maximum and minimum lengths (e.g. to support ADEXP messages).

4.3 Scope of Profile

4.3.1 The AFI-ATSMHS Profile specifies a number of AMHS protocols and systems capabilities for the exchange of ATS messages between direct and indirect AMHS users through international MTAs. In other words, the Profile is intended to ensure end-to-end message transfer between International COM Centres over AMHS.

4.3.2 The Profile is applicable to the following aspects of message interchange:

Transfer of messages between the AMHS systems at International COM Centres operated by different ANSPs;

Submission, Delivery and Retrieval of messages that are to be transferred between AMHS systems operated by different ANSPs;

The content of Message Envelopes, IPM Headings, Body Part Types and AMHS Addressing used for the protocols identified above.

4.3.3 The Profile does not specify any of the purely local requirements within an ANSPs individual systems – e.g. MTS Access, MS Access, and interconnections between MTAs within an ANSP's Private Management Domain, other than to ensure adequate interchange of ATS messages internationally. Nor does it specify aspects of interconnections between Regional AMHS/AFTN gateways where additional requirements may apply, such as support of an ATN lower layer protocol stack as specified in ICAO Document 9880, Part III [4].

4.3.4 Access to the Directory Information used to support Directory Name Resolution and address mapping between AFTN and AMHS address forms is indicated for information only.

4.3.5 The following diagram illustrates the scope of the protocols and system types specified in the AFI-ATSMHS Profile:

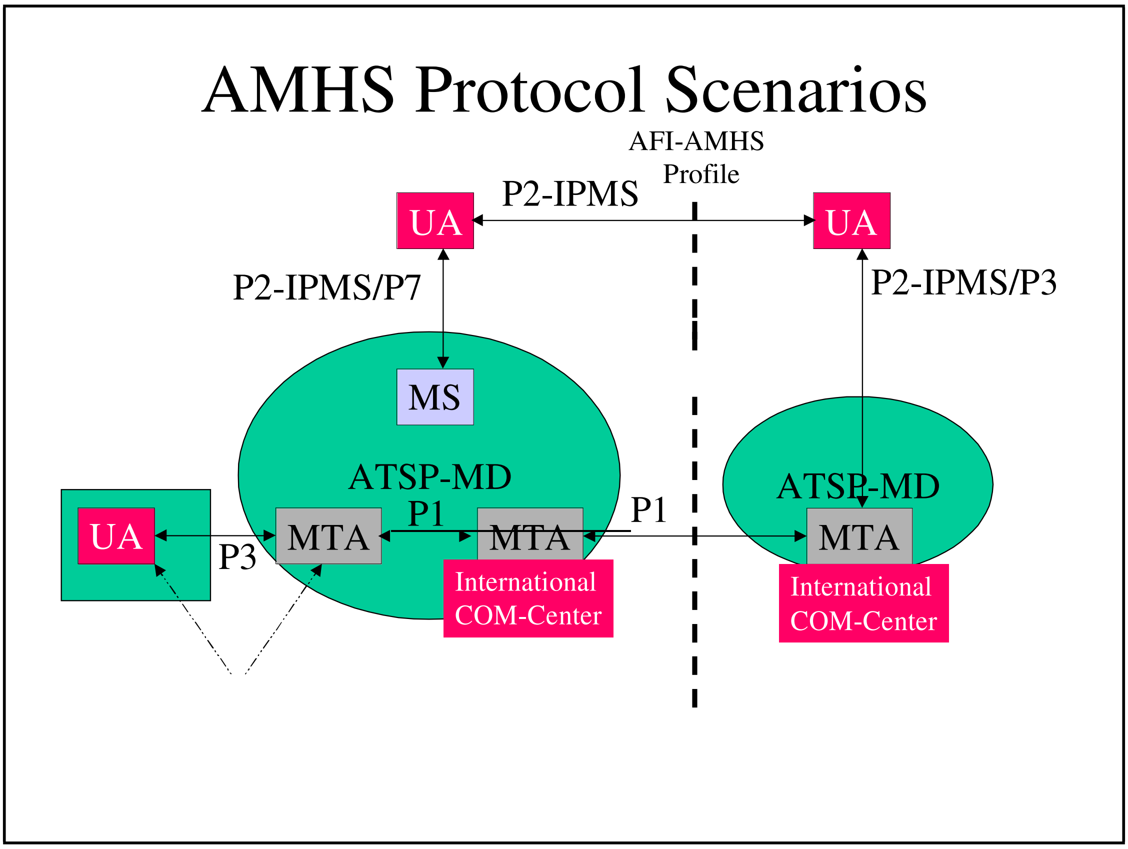

Figure 5: AMHS Systems and interconnecting Protocols

4.3.6 The Profile applies to the following AMHS system components:

User Agents	UA
Message Transfer Agents	MTA
Message Stores	MS

4.3.7 The Profile applies to the following AMHS protocols:

IPM Content	P2
Message Transfer	P1
Message Submission/Delivery	P3
Message Retrieval	P7

4.3.8 The Profile specifies a Profile of ATS Message Handling Service conformance called the AFI-AMHS Profile. It is based on the requirements of following:

The Basic ATS Message Handling Service (Bas), introduced in the Doc 9880, Part II, para. 1.1.3-1.1.8;

A number of further Functional Groups and options selected from the Extended ATS Message Handling Service (Ext), introduced in the Doc 9880, Part II, para. 1.1.3-1.1.8;

4.3.9 The resulting scope is sufficient to ensure inter-State message interchange using AMHS according to the Basic AMHS requirements stated in Doc 9880, which covers Basic Message Transfer Capabilities, Distribution Lists, appropriate message size capability and Legal Recording.

4.3.10 In addition, the following requirements are included:

Use of TCP/IP as the underlying Data Communications Service;

It must be pointed out that specification of an AMHS based on TCP/IP necessarily references a wide range of standards from different sources. This is complicated by the fact that procurement of a complete AMHS/TCP solution involves the specification of three different system component types (Message Transfer Agents, Message Stores and User Agents), each of which has a number of implementation options. The Profile therefore also provides guidance on the correct use of the referenced ISO/IEC ISPs, ICAO Documents and Internet RFCs for each type of system.

Provision for the transfer of binary data using the File Transfer Body Part

It must be pointed out that the originally planned mechanism for this requirement was to use the Bilaterally Defined Body Part. However, this was found to be deficient in two ways:

a) its use is now discouraged by the base standards;

b) it provides no way for recipients to determine the nature of the binary encoding actually contained in a received Bilaterally Defined Body Part.

For these reasons, the use of the Bilaterally Defined Body Part was removed from old Doc 9705 during 2003 now Doc 9880, Part II, and was replaced by the File Transfer Body Part, which is known to overcome the previously mentioned drawbacks.

4.3.11 Security requirements are not a mandatory part of the AFI-ATSMHS Profile. However, the Profile mandates IP address validation and the protocol includes system identification following transport connection establishment. It must be pointed out that certain Messaging Application Security functions are also mandated in the MHS S0 optional

Functional Group for the Extended ATS Message Handling Service but these are not mandated by this Profile.

4.4 Use of the Directory

4.4.1 The primary requirement for the use of the directory that arose within the SPACE project was to support the AFTN<>AMHS Gateway Address Translation process. However, for the following reasons, the Use of Directory is not mandated in the Profile:

There are other ways to implement the distribution of the necessary directory information which are viable at least in the early phases of AMHS implementation;

Some States will not implement the directory (nor access it) in the first implementations of AMHS. Some of the reasons for this are that they want to implement AMHS first before taking the next step to the Directory. Also, some currently available AMHS products do not support access to the Directory;

Some States foresee that Directory Access as specified in Doc 9880 [5] using X.500 DAP is too costly in terms of software purchase, and they would like to be able to use LDAP (a more cost effective RFC-based equivalent). However, there are no currently available LDAP schema standards covering some of the ATN Directory-specific requirements (and some aspects of X.400 support). There are also no suitable standard LDAP products available;

In some cases, it is not quite clear what elements of the ATN-Directory Schema are required to support different AMHS functions (e.g. in terms of directory information). These issues need to be resolved by further guidance material on the use of the ATN/AMHS Directory by the ACP. Currently, work is ongoing to fulfil this requirement.

4.4.2 For these reasons, the Use of the Directory has not been included in the first version of the Profile.

5 System implementation - Guidelines for system requirements

5.1 Introduction

5.1.1 This section is intended to deal with technical and operational requirements for a COM system replacing the AFTN system by an AMHS or adding the ATSMHS capability. As indicated by its title, this section covers guidelines for requirements not specified in the AMHS technical specifications, but considered by the Group important enough for being included in a Call for Tender for the procurement of an AMHS system.

5.1.2 The main input of this section was a subset of the specifications of an actual Call For Tender issued by one of the Group members, adapted and modified in order to have a 'template' able to be used by any ANSP who intends to procure an AMHS system.

5.1.3 The section covers technical and operational requirements like:

General facilities

Addressing - mapping table facilities

Queue management facilities

Message repetition facilities

Tracing facilities

Sizing

Availability and reliability

5.1.4 For such a COM system in the following paragraphs the term "**AMHS System**" will be used.

5.1.5 Due to the character of this section (as guidelines for system requirements) the term "**should**" is used. In a specific Call for Tender this term can be replaced by shall.

5.2 General requirements

5.2.1 The AMHS System should implement the ATSMHS and AFTN/AMHS Gateway facilities in accordance to the specifications defined in the latest approved ATN technical specifications for Basic Services, but supporting AFTN messages with a message length up to 64Kbytes.

Note. – This requirement is not covered by the technical specifications, which mandate support of standard AFTN message length only.

5.2.2 The AMHS System should support several simultaneous associations with an MTA partner (at least, up to 5).

5.2.3 The AMHS System should support simultaneous associations with several MTA partners (one or several associations with each MTA partner) with the same or different “transport” protocols (e.g. TCP/IP to be used within AFI, ATN/OSI).

5.2.4 The AMHS System should support the total number of simultaneous associations (sum of all associations) without any restrictions caused by inherent limitations of the system (memory, interfaces, etc).

5.2.5 The AMHS System should allow control of establishment of associations with MTA partners via on-line operator commands; i.e., it should be able to:

Prevent/allow the establishment of associations with a given MTA partner by AMHS System (local MTA), by MTA partner only or by both partners.

Prevent/allow the establishment of associations with all configured MTA partners by AMHS System (local MTA), by all MTA partners only or by all partners.

Force the termination of associations already established with a given MTA partner.

Force the termination of associations already established with all configured MTA partners.

Note. – The number of actual simultaneous associations to be supported will depend on:

- *the target 'logical' AMHS network topology: for example each centre establishes direct associations with all the other centres or each centre establishes associations with adjacent centres only (as in AFTN);*
- *whether permanent or dynamic connections will be established. Such distinction is only applicable in case there is no requirement for continuous traffic exchange.*

5.2.6 The AMHS System should implement MTA queues. These queues will keep the AMHS messages that:

a) either are pending to be sent;

b) or have been transmitted but for which a delivery report is expected.

Note1. – The queue referred to in a) should be implemented in the MTA.

Note2. – The queue of messages for which a DR is expected should be implemented in the User Agents and MTCUs of the AFTN/AMHS gateways.
The reaction of an AMHS System in case of loss of a DR should be fixed (implementation matter): E.g., would it have to resend the message after timeout? How many attempts to resend the message should be made? A DR or NDR is addressed to the originator of the message; therefore it should be left to the originator to react upon non-arrival of a DR as it is his task to react upon reception of a NDR. If the originator is an indirect (AFTN) user, the AFTN/AMHS gateway has to perform this task on his behalf. Furthermore, a report may take another route than the message it refers to, that means it does not necessarily pass through the same MTAs as the original message.

5.2.7 There should be a logical MTA queue per configured MTA partner. Management of these queues is specified in section 5.4).

5.2.8 The configuration of an MTA partner (via on-line commands) should provide flexibility for each of its parameters. For example:

a) It should be possible to configure the “transport” protocol (e.g. ATN, TCP/IP, TP0/X.25) to be used per each MTA partner.

b) In case of selection of TP0/X.25, it should be allowed to configure at least two local X.25 attachments to be used for the connections, several calling – called addresses to be used for initiating a call or acceptance of an incoming call, etc.

c) It should be possible to configure the maximum number of simultaneous associations with each MTA partner.

d) It should be possible to configure whether the associations have to be left permanently established or whether they have to be established and closed depending on traffic.

5.2.9 The AMHS System should allow configuration of all profile items if possible.

5.2.10 The AMHS System should allow configuration of the following profile items, at least:

a) Mapping between AFTN priorities and AMHS Message Transfer Envelope priorities.

b) Values of “rn” and “rnr” in the notification-requests element in the recipient fields in The IPM heading. These values should depend on the value of the AFTN priority.

Note1. – Both functions should be implemented in the UAs and MTCUs of the AFTN/AMHS gateway since the MTA does not deal with the ATS Message Priority (or AFTN priority) which is contained in the ATS Message Header as part of the IPM body.

Note2. – The technical specifications specify the values of these profile items. It is considered that the implementation should allow the possibility to change them just by configuration in case operational experience recommended other settings. The processing is implementation matter.

5.3 Addressing – mapping tables requirements

5.3.1 The AMHS System should support the CAAS (see section 3.2).

5.3.2 The AMHS System should process and manage AMHS messages received with the O/R name in the XF Addressing Scheme also, even if the ANSP has chosen the CAAS for its internal users.

5.3.3 The AMHS System should provide mechanisms to import mapping tables needed in the AFTN/AMHS Gateway. The tables to be imported will be downloadable from the AMC system.

5.3.4 The implemented facilities in the AFTN/AMHS Gateway which map an AFTN address to an O/R name should be flexible enough to accommodate different O/R structures (Addressing Schemes) and use the minimum number of configuration / lookup tables with the minimum number of entries. As an example for the implementation of the mapping of an AFTN address to an O/R name, the following information should be entered in configuration tables:

a) Attributes and associated values that are fixed for each State. E.g. in the case of States using the address scheme described in section 3.2 the attributes and associated values to be entered should be Country, ADMD and PRMD.

Each entry will be indexed by the ICAO routing area or State/territory identifying letters (1 or 2 first characters of the AFTN address).

b) Attributes whose values can be determined directly from the AFTN address. E.g., in the case of States using the CAAS described in section 3.2, the Organisation Unit 1 attribute (first to fourth characters in the AFTN address) and the Common Name (all characters in the AFTN address) should be declared here for them.

c) Attributes whose values depend on a mapping table. For each such attribute for each State, the following should be specified: the name of the mapping table and the subset of the AFTN address (e.g. one to four first characters, the complete AFTN address, wild characters could be used to define the subset ...) that gives the index to the mapping table. The mapping table itself should also be provided. E.g., in the case of countries using the CAAS address scheme described in section 3.2, the value for the Organisation attribute should be defined this way.

5.3.5 The possibility to use a directory should also be contemplated, even if this is not part of the Basic Services.

5.4 Queue management requirements

5.4.1 The AMHS System should provide, in addition to a pure diversion facility of outgoing queues, a reprocessing of messages in X.400 (outgoing) queues in case of longer outages of adjacent MTAs (non-reachability).

Note. – Such reprocessing facilities will be very important during the time period when both AMHS and AFTN/CIDIN centres coexist in the AFI Region.

5.4.2 Two types of reprocessing should be envisaged:

at the pure X.400 level;

at the AFTN level (in the case of AFTN/AMHS Gateways).

Reprocessing at the pure X.400 level

5.4.3 The reprocessing at pure X.400 level should allow:

to extract messages waiting in an X.400 queue from this queue;

to process these messages again by the X.400 routing software; and

to route according to possible new or temporarily modified X.400 routing tables.

Such a mechanism would allow to extract the messages from the queue associated to a non-reachable MTA. The messages could be routed through another centre (MTA) and forwarded through the alternate route only for those recipient addresses for which alternate routes have been activated. For all other recipients addresses the messages remain in the queue. This kind of reprocessing prevents a general forwarding of messages to other centres (MTAs) containing recipient addresses for which rerouting is not intended.

5.4.4 The reprocessing at the pure X.400 level should be present in the ATS Message Servers, in AFTN/AMHS Gateways.

Reprocessing at the AFTN level

5.4.5 The reprocessing at AFTN level should allow:

to extract messages waiting in an X.400 queue;

to re-process them by the AFTN layer; and

to route them according to the current AFTN, CIDIN and X.400 routing tables respecting the updated route availability information (predefined alternate routing).

This reprocessing would solve the problem of non-reachability due to outages, in a heterogeneous AFTN/CIDIN/AMHS environment.

5.4.6 An X.400 queue can contain messages, reports and probes. The AFTN reprocessing function should only concern the messages.
These messages can be of different 'types': messages from AFTN/AMHS gateways, 'pure' UA to UA exchanges, etc. All these messages will be IPM messages, so there is no way to distinguish them at the X.400 (envelope) protocol level.

5.4.7 The reprocessing should be restricted to messages generated by an AFTN/AMHS gateway.

5.5 Message repetition requirements

5.5.1 The AMHS System should provide powerful message repetition facilities in the AFTN, CIDIN and AMHS subsystems implementation.

5.5.2 The repetition facilities should be able to repeat messages as they were originally transmitted i.e. sent to all recipients following the same transmission paths.

5.5.3 Additionally, the repetition facilities should be able to specify (with the use of wildcards) 'detailed' or 'generic' destinations. Such destinations can be an AFTN address, an O/R name, all AFTN addresses mapped to a given Ax, all O/R names of a given PRMD, etc.

5.5.4 The AMHS System should find all the messages that were transmitted to such specified 'generic' destinations within a specified time interval and retransmit them only to pending destinations and following the current routing. To avoid a transmission to other destinations originally contained in the message the addresses not matched by the 'generic' destination should be suppressed (address stripping).

5.6 Tracing facilities requirements

5.6.1 The AMHS System should provide a facility to allow generation of X.400 probes.

5.6.2 The user interface of the facility should allow entering of the priority, the O/R name of the originator / destinations and the message length.

5.6.3 The AMHS System should send the reports regarding the probes (delivery, non-delivery) to a configurable instance (e.g. the rejection queue).

Note. – This requirement relates to a user interface requirement. The user should get some *notification when the delivery report related to the probe has been received. It is an implementation matter to decide whether this is performed just by allocating a fixed originator O/R name to one of the queues of the system or by another way.*

The contents of such reports should be decoded and presented in a 'human' readable and understandable format.

5.6.4 The AMHS System should provide association-tracing facilities to monitor in real time the establishment, interruption and finalisation of associations related to adjacent MTAs.

5.7 Sizing requirements

5.7.1 The sizing of the AMHS System operational platform should support the traffic in peak hour situations with:

a) Average peak hour total CPU usage at 30% maximum.

b) Communication adapters loaded at a maximum 30% of their real bandwidth capacity (not the theoretical one) and excluding the redundancy needs.

Note. – The previous values have to be reconsidered by each ANSP depending on the expected lifetime of the AMHS System. As e.g., if the lifetime is expected to be 10 years and the traffic estimates for the peak hour relate to the end of the lifetime, the usage requirements for the CPU and the communication adapters should be greater than 30% (if not, the purchased system will be oversized during quite a number of years).

c) Processing time of a message (High QoS flow type class, see section 3.1) at least less than 1.5 seconds. The processing time is defined as the difference between the moment the latest character of the message enters into the AMHS System and the moment the first character of the message is sent out. This applies for all implemented in / out protocol combinations. For messages of other flow types, the processing time should be less than 3 seconds.

Note. – This value, especially for AMHS, has significant implications in the platform sizing and total network transit time (this also depends on the network topology, see section 3.3 AMHS topology). If the value is too low, a very powerful platform is required; If the value is too high, it could introduce a significant delay in the overall message transmission (specially if the other centres also have high values).

d) Response time to configuration / management on-line commands less than 3 seconds. This response time is related to requests from a management position for actions which do not require a query / browsing of a log (e.g. close a PVC, create an Ax, etc).

e) At least 50% of the disk space remaining available after:

i) all the standard and specific developed software versions (including the possibility of more than one software versions and two configurations per version) are present on disk,

ii) all logs and archive folders corresponding to the number of days to be kept on-line in the system are present on disk.

Note. – The precise number of days will depend on the particular policy of each ANSP to comply with the ICAO Legal Requirements (see section 9.1

Legal Recording in AMHS).

If its policy indicates that all the data has to be kept on the AMHS System, the system should support at least 30 days. If the policy indicates that the data are saved for such purpose somewhere else (e.g. in another system, in an external media like CD-ROM, DAT, cartridge, etc), data concerning fewer days needs to be kept on-line (e.g. three days, one week...).

Note. – As for the CPU and communication adapter usage, the value for disk space shall be reconsidered by each ANSP depending on the expected lifetime of the AMHS System and the traffic estimates related to.

5.8 Availability and reliability requirements

5.8.1 The AMHS System should operate 24 hours per day and 365 days per year.

Note. – The values provided below should be considered as 'minimum' requirements. Each ANSP should reconsider them according to its own policy and internal SLAs with its internal users.

5.8.2 Interruptions for system maintenance and installation should be limited to the strict minimum and should be less than 60 minutes.

5.8.3 After power is switched on, the AMHS System should be fully operational after a maximum of 15 minutes.

5.8.4 The AMHS System should auto monitor:

the state of its application processes;

the state of its system processes;

the state of its system components (hardware).

5.8.5 The AMHS System should generate an SNMP MIB of the states monitored (see above).

5.8.6 The AMHS System should automatically try to recover from failure conditions in its application processes. If it is not possible to recover without impacting the service, the AMHS System should terminate all its application processes in an orderly manner and restart them afterwards automatically.

5.8.7 The AMHS System should allow an operator to:

a) Stop the AMHS application gracefully (with automatic restart).
b) Stop the AMHS application gracefully (with no automatic restart).
c) Force the AMHS application to stop (with no automatic restart).
d) Start the AMHS application with message recovery (messages that were in queue when the system was stopped are processed and forwarded).
e) Start the AMHS application without message recovery (messages that were in queue when the system was stopped are discarded).

5.8.8 The AMHS System should lose no message that has been acknowledged by it (according to the respective messaging protocol), unless an operator explicitly requests to drop the messages.

5.8.9 The AMHS System should lose no message because of its load.

5.8.10 In case of a switchover (cluster, master/standby) configuration the following requirements apply:

a) After detection of failure of the primary system unit or after an operator command, the switchover process should last less than five minutes. The duration of the switchover is counted as the time from the failure detection (or operator command) until the time the AMHS restarts forwarding messages again (assuming there are messages in queue or there are new incoming messages).
b) The time needed for the standby unit to detect failure of the primary one should be less than three minutes.
c) The switchover process should be completely automatically without requiring any plugging/unplugging of any type of cables (communications, disks ...). A matrix switch action (if a matrix switch is proposed) is not considered as a cable plug / unplug.

5.8.11 Any period of time longer than one minute, during which the AMHS System does not perform message switching (in a total or partial manner) due to software or hardware problems, should be considered as an interruption of service.

5.8.12 An interruption of service of an AMHS System should be less than 10 minutes when the recovery is automatic. The duration of an interruption is calculated as the time from the moment the last received message was forwarded until the moment the AMHS System starts forwarding messages again (assuming there are messages in queue or there are new incoming messages).

5.8.13 There should be no more than one interruption of service without automatic recovery in a sliding window of six months.

5.8.14 There should be no more than one interruption of service with automatic recovery per day.

5.8.15 There should be no more than two interruptions of service with automatic recovery per month.

5.8.16 There should be no more than three interruptions of service with automatic recovery in a sliding window of three months.

5.8.17 The MTBF of the AMHS System hardware should be higher than 52 weeks.

5.9 Requirements for statistics

5.9.1 The AMHS System should monitor and produce statistics per direct MTA partner as follows, where the term "data message" includes all X.400 P1 information objects, i.e. messages, probes and reports:

a) Number of data messages transmitted
b) Average size of the data messages transmitted

c) Maximum size of the data messages transmitted
d) Average number of destination addresses per message transmitted
e) Number of data messages received
f) Average size of the data messages received
g) Maximum size of the data messages received
h) Average transfer time
i) Number of delivery reports transmitted (a subset of item a)
j) Number of non-delivery reports transmitted (a subset of item a)
k) Number of delivery reports received (a subset of item e)
l) Number of non-delivery reports received (a subset of item e)
m) Minimum size of data messages received
n) Minimum size of data messages transmitted
o) Maximum, mean and minimum response time
p) Number of recipients processed
q) Number of messages deferred (the criterion for a deferred message should be specified by a configurable system parameter)
r) Number of messages redirected
s) Number of messages rejected
t) Number of loops detected

5.9.2 The AMHS System and its management tools should enable to monitor and produce statistics per direct MTA partner, related to traffic volume and quality of service at an overall system level, as follows:

a) Overall traffic volume at the level of IP packets;

b) Maximum outage duration of association between MTAs (if any);

c) Cumulated outage duration of association between MTAs (if any).

Note. – The use of IP network measurement tools distinct from the message switch, and/or manual intervention may be required to produce these elements.

5.9.3 Additionally the AMHS System should produce the information specified in 5.9.1 and 5.9.2 for all partner MTAs as a total.

5.9.4 The AMHS System should be able to generate the above statistics in at least the following intervals: 1 day interval, 1 hour interval, 30 minutes interval or better.

5.9.5 The AMHS System should be flexible in configuring other intervals for application statistics generation.

5.9.6 The AMHS System should be flexible in generating statistics at a more detailed level, as e.g., MTA route entries, particular O/R attributes, individual O/R names (to be discussed).

Note. – Each ANSP may consider what requirements on statistics are put on the AMHS System in accordance with its requirements (national and international) and its policy for statistics production. E.g., there can be ANSPs which transfer the traffic logs to another system which will produce all required statistics; in such a case, the AMHS System may be relieved of too many statistics requirements. If an ANSP does not have such other system, the AMHS System itself should produce all statistics needed.

5.9.7 The AMHS System should be able to export specific statistic files on a monthly basis. Such a statistic file should contain daily as well as peak hour statistical data in a standard format, covering certain items in 5.9.1 and all items in 5.9.2, because of their specific international relevance. Detailed specifications of the file formats and statistical indicators are provided in the ATS Messaging Management Manual.

6 AMHS management

6.1 Introduction

6.1.1 In general, network management is essential for reliable and efficient operation of a network like the AFI AMHS Network.

6.1.2 This chapter contains a general introduction on the management aspects for an AFI AMHS network. It contains a list of required functions that are to be fulfilled by a management system.

6.1.3 The breakdown of the management areas is according to the ISO FCAPS scheme.

6.1.4 At the end in section 6.5 the AFI approach of AMHS Network management by implementing the ATS Messaging Management Centre is described.

6.2 Requirements for AMHS Management

6.2.1 The following AMHS Management activities can be distinguished:

Timeframe **Activity**	**Online 24 hr*7 day**	**Off line - short term**	**Offline – long term**
Fault Management	Helpdesk, fault reporting. 1st line support. Service availability monitoring	Fault resolution, fault management	High level changes to increase reliability, reduce user queries
Configuration Management	These are not a regular feature of online systems management. System and user changes recorded online but usually applied to offline system.	Activation/turn-up of changes. Regular published changes	High level planning, for international connectivity and national service upgrades
Accounting management	N/A	Production of regular statistics	Policy and planning activities relating to budgeting, charging, capacity planning
Performance management	Monitoring utilisation, processors, queues, connections, disks etc.	Performance tuning activities	Long term and international planning for capacity management

Timeframe / Activity	Online 24 hr*7 day	Off line - short term	Offline – long term
Security	Monitoring for attacks, taking countermeasures	Regular health checks, reviewing warnings from industry and other ANSPs, security training	Security policy, significant architecture/topology changes to increase security

Table 6: Breakdown of activities by timeframe

6.3 System Management data flows

6.3.1 How system management will be implemented and operated at local level can be freely chosen by a State. The ATN technical specifications define requirements to make information available to other States through XMIBs, with as a primary goal the support of boundary management.

6.3.2 The ATN technical specifications define the XMIB sets, and the information is used to serve the following purposes:

Enable other participating organisations to query the current operational status of the ATN system (ES or IS);

The cross domain MIB should support the capability to allow a SM Manager to be warned by notification as soon as an error occurs in an adjacent domain.

6.3.3 This "public" management information is to be made freely available by the State to the international community.

6.3.4 Alarms raised in one management domain that affect the provision of AMHS service shall be made available to other management domains.

Note. – The exact standard distribution of reports and alarms is for further study.

6.4 Realisation options

6.4.1 Information database

6.4.1.1 For the exchange of information with the management database the ISO XMIB solution is foreseen in the technical specifications. In this context, States have been requested to implement XMIBs from the onset of AMHS for international co-ordination. Eventually a conversion mechanism should be implemented.

6.4.1.2 Such an implementation should cover both the AMHS application (entry and exit MTAs, Gateways, MTCUs and routes through a State carrying traffic) and the underlying ATN network XMIBs.

6.4.1.3 A capability to broadcast alarms to other States should be foreseen.

Note. – The use of XMIB is under discussion. Especially in the light of TCP/IP in the AFI Region other options (MIB) should be studied.

6.4.2 Fault management

6.4.2.1 Fault management can be subdivided in 3 distinct areas:

Fault rectification – the process of providing a long term solution to a fault. This is highly implementation dependent and thus very much a national issue.

Fault management – the process of ensuring that faults are correctly recorded, assigned for rectification and the entire process managed Also this is a national function.

Fault reporting – covers the area of helpdesks and first line support and spans both local and international systems.

6.4.2.2 Helpdesks can be organised either nationally or internationally. In the international model a centralised regional or global helpdesk operates on behalf of member States which maintain the operational responsibility for their own domains.

6.4.2.3 The international approach has a better overview of the network as a whole, offers economies of scale and relieves national operations centres. The national approach deals more efficiently with local users in the local situation.

6.4.2.4 Weighing advantages and disadvantages a regional helpdesk has been chosen for the AFI AMHS.

Note. – The Terms of Reference of the Helpdesk are to be defined. For the time being the helpdesk is of passive nature and is intended to operate off-line.

6.4.3 Configuration Management

6.4.3.1 Although Configuration Management is a local responsibility there is a significant requirement for co-ordination of addressing and routing information.

6.4.3.2 An AMHS Offline Management Centre is created to consolidate, co-ordinate and distribute AMHS address and routing information across the AFI Region. The configuration changes follow the 4-week AIRAC cycle.

6.4.3.3 The following information will be co-ordinated and maintained:

Declaration and changes to PRMD;

Declaration and changes to mapping of “4 character location indicator” to “Geographical Unit”, i.e. relationship between OU1 and O attributes;

Declaration and changes to mappings of “8 character AFTN address” and Geographical unit i.e. Common Name to OU1;

Declaration and changes of network addresses for primary and backup boundary MTAs and AFTN/AMHS gateways;

General awareness of deployment and transition activities;

Routing and alternate routing.

6.4.3.4 ICAO will hold a registry of PRMDs.

6.4.4 Accounting management

6.4.4.1 In the initial phase of AMHS operation accounting will not be performed.

6.4.4.2 Cost assignment will eventually be locally introduced.

Note. – The requirements for eventual later implementation of the facility are under study.

6.4.5 Performance management

6.4.5.1 Performance

6.4.5.1.1 Online performance monitoring includes monitoring of metrics like queue size, transit times utilisation factors and status, where manual and/or automatic procedures are being invoked when thresholds are passed.

6.4.5.1.2 Offline performance management is aimed at the ability of the service to meet future needs. This requires accurate statistics on traffic patterns and system performance.

6.4.5.1.3 Both management aspects are local to an ANSP and no matter for international harmonisation.

6.4.5.2 Statistics

6.4.5.2.1 It is recommended that statistics should be collected using the internationally agreed objects (MTA). (For detailed requirements for statistics see 5.9)

6.4.5.2.2 Implementers should use a flexible design and should be able to obtain the information down to the level of individual operators or recipients with a granularity of 30 minutes or better.

6.4.5.2.3 A minimum set of monthly statistic should be exportable. Such a file should contain daily as well as peak hour statistical data in a standard format. Detailed specifications are provided in the ATS Messaging Management Manual.

6.4.5.3 Reporting of statistics

6.4.5.3.1 The statistic file containing daily as well as peak hour statistical data should be provided to the ATS Messaging Management Centre monthly.

6.4.5.3.2 There are no specific recommendations for statistics that are to be reported for national use.

6.4.6 Security Management

6.4.6.1 The management of security within a State is considered to be a local issue. However, when a breach of security or a threat is detected, it is recommended that the helpdesk is informed, and that the helpdesk subsequently passes on security warnings to other States and Regions and co-ordinates exchanges.

6.5 Implementation of AMHS Management in the AFI Region

6.5.1 Introduction

6.5.1.1 This section is intended to give the reader information necessary for an understanding of AMHS Management as currently planned, and has been written for those implementing, operating, using and planning the procurement of management systems.

6.5.1.2 Section 6.5.3 defines a group of functions known as "off-line" management functions. To a certain extent, these functions represent updated CIDIN Management Functions already being carried out. They are not highly demanding in an implementation and operational sense and shall be introduced first.

6.5.1.3 The other functions in the context of AMHS Management are termed "on-line" functions. They are defined in section 6.5.4.

6.5.2 On-line and off-line management

6.5.2.1 The Terms “Off-line” and “On-line”

6.5.2.1.1 A basic principle underlying the structure of AMHS management is the distinction between the two groups of functions designated as "off-line" and "on-line" management functions.

6.5.2.1.2 **Off-line** functions do not need to be executed in a short time period. These relate to medium and long-term requirements and include, e.g., collection and processing of information from COM Centres (inventory, planning, addressing, statistics, etc.) and preparation of configuration proposals (routing, addressing). Provision of technical support (help desk, consultancy, etc.) is also included in off-line management, even though these functions do not belong to one of the OSI Functional Areas.

6.5.2.1.3 **On-line** management refers to functions that shall be executed in a short time period in order to maintain the level of service required from AMHS. This necessitates the rapid exchange of management information between the COM centres and possibly between the COM centres and AMHS Management Unit (on-line Regional Help Desk).

6.5.2.2 The Distinction

6.5.2.2.1 The terms “off-line” and “on-line” are used to classify two separate groups of functions. The following table summarises the distinction with respect to a number of characteristics.

Characteristic	off-line	on-line
on-line connections between the systems?	not essential	essential
human intervention in the “management loop”	yes	in transition phase and in exceptional circumstances
new application software to be implemented in AMHS centres?	not essential	essential
operational time constraint	a few time-critical functions	more time-critical functions
degree of technical sophistication	relatively simple	more complex
period of operation	office hours	7 days / 24 hours
order of implementation	it is being implemented	to be studied

Table 7: Characteristics of “off-line” and “on-line” functions

6.5.2.3 Implementation Aspects

6.5.2.3.1 The off-line group of functions is less demanding than the on-line functions to implement. They can be introduced within a relatively short timescale.

6.5.2.3.2 The on-line functions are more ambitious and not yet defined as the off-line functions. The timescale for their implementation is longer and network management experience in the AMHS context needs to be built up before they can be introduced. The introduction of an on-line mode of operation supplementing the off-line mode is expected to be a major design issue.

6.5.3 AMHS off-line Management

6.5.3.1 AMHS off-line Management is described in the ATS Messaging Management Manual. ATS Messaging refers to the integrated, heterogeneous messaging environment comprising AFTN, CIDIN and AMHS.

6.5.3.2 The manual, developed by AFI Region in close cooperation with ICAO AFSG, is a companion document to the CIDIN Management Manual, and it is intended to give the reader all additional information necessary for an understanding of the integrated AFTN/CIDIN/AMHS off-line Management.

6.5.3.3 The ATS Messaging Management Manual describes the framework in which the services of the ATS Messaging Management Centre (AMC) are provided to States/ANSPs in the EUR Regions, and, in a more limited manner, to States/ANSPs in other Regions. This framework is largely based on the current CIDIN Management framework and organisation.

6.5.3.4 Two categories of AMHS off-line Management Functions are defined, i.e.: Implementation Support Functions primarily for States in the process of implementing AMHS, and Operational Functions in support of States with AMHS in operational service:

6.5.3.5 Implementation Support Functions:

Download support information

AMHS PDR monitoring

Inter-working test support

View operational data

Implementation planning

Helpdesk function

6.5.3.6 Operational Functions:

Network inventory

Network planning

Routing management

Address management

AMHS user capabilities management

Security management (for future development)

Statistics

Support

6.5.3.7 The AMC procedures associated with the performance of the functions by Co-operating COM Centres (CCCs) are described in the ATS Messaging Management Manual; they are identical to those currently used in the CMC.

6.5.3.8 The goal of the AMC is twofold:

the AMC facilitates the transition from CIDIN/AFTN to AMHS, particularly with routing management and address management functions;

the AMC provides new tools in support of AMHS operations.

6.5.3.9 When States in the AFI Regions implement AMHS, the transition is complex to manage. Considering that ill-coordinated actions may create risks for the overall ATS Messaging quality of service, it is therefore recommended that every State implementing AMHS in the AFI Regions participates in AMC activities.

6.5.3.10 Detailed information on the AMC organisation, features, functions, procedures and implementation issues can be obtained from the CMC/AMC. .

6.5.4 AMHS on-line Management

- to be studied if needed -

7 Tests and validation of AMHS systems

7.1 Objective

7.1.1 Experience has shown that, although it is claimed that systems have been implemented according to the one set of protocol specifications, they are often not capable of inter-working. This is due to errors in implementation or to different interpretations of the specifications (SARPs and Doc 9880). Testing and validation of systems according to the same set of principles aims at the detection of such errors and the prevention of incompatibility instances.

7.1.2 The primary objective of this chapter is to formulate recommendations for testing the ability of a given AMHS implementation to function as required at the level of an International Communication Centre within the AFTN/CIDIN/AMHS network environment.

7.1.3 This chapter provides general information on the AMHS testing concept. The actual testing methodologies, configurations and procedures are defined in Appendix C, Appendix D, Appendix E and Appendix F. In these Appendices, tests are described in sufficient detail to give an appreciation of the variety of functions that are covered, the facilities required and the expected results.

7.2 General Principles

7.2.1 The creation of standards for testing is subject to consideration by a number of standardization bodies concerned with open systems (e.g. ISO, ITU-T).

7.2.2 In these standards, *conformance testing* is prescribed for testing a protocol implementation (IUT) with respect to its specification.

7.2.3 If conformance testing could be done in a complete and correct manner then two different implementations that passed the conformance test would be interoperable. In practice, conformance testing does not necessarily reach the intended point of completeness and correctness. Consequently, conformance testing may be followed by *interoperability testing* to determine whether two or more implementations will produce the expected behaviour under actual operating conditions.

7.2.4 In a more detailed analysis of the objectives of conformance and interoperability testing the following distinctions can be made:

> The primary objective of interoperability testing is to confirm the end-to-end interoperability of two systems, which have both been developed to a common specification. Performance and load testing are possible, at least in principle.
>
> Conformance testing can be defined as the exhaustive testing of an IUT against the functions and procedures defined in an agreed standard. Performance and load testing are not usually part of conformance testing which is restricted to the “logic” of the protocol implementation.

7.2.5 Furthermore, two essential practical differences between conformance and interoperability testing should be pointed out:
Incorrect protocol behaviour. – Conformance testing allows "provoking" of the IUT, through incorrect protocol behaviour, in order to study its stability. Interoperability testing provides only limited possibilities due to (normally) correct protocol implementations in real systems.

Distribution of test locations. – Conformance testing can be performed locally between IUT and a conformance testing equipment. Interoperability testing is normally distributed over at least two remote locations, therefore requiring more co-ordination effort.

7.2.6 Figure 6 depicts the principal differences in test arrangements for interoperability and conformance testing.

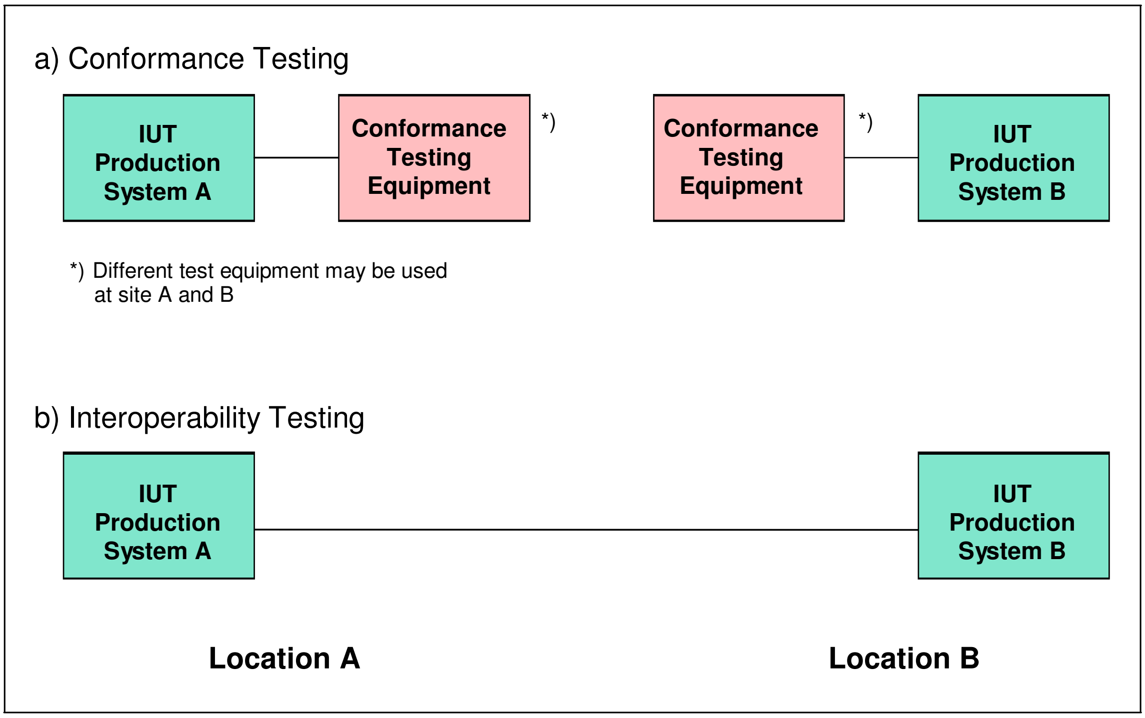

Figure 6: Principal test arrangements for conformance and interoperability testing

7.3 AMHS testing concept

7.3.1 Testing strategy

7.3.1.1 AMHS system implementations consist of protocol layers according to the principles of the Reference Model for Open Systems Interconnection. The AMHS functions to be tested reside in the application layer of the ISO/OSI reference model. The underlying layers provide supporting communication services, however they are not primarily subject to testing.

7.3.1.2 Figure 7 provides a generic functional presentation of an AMHS implementation under test.

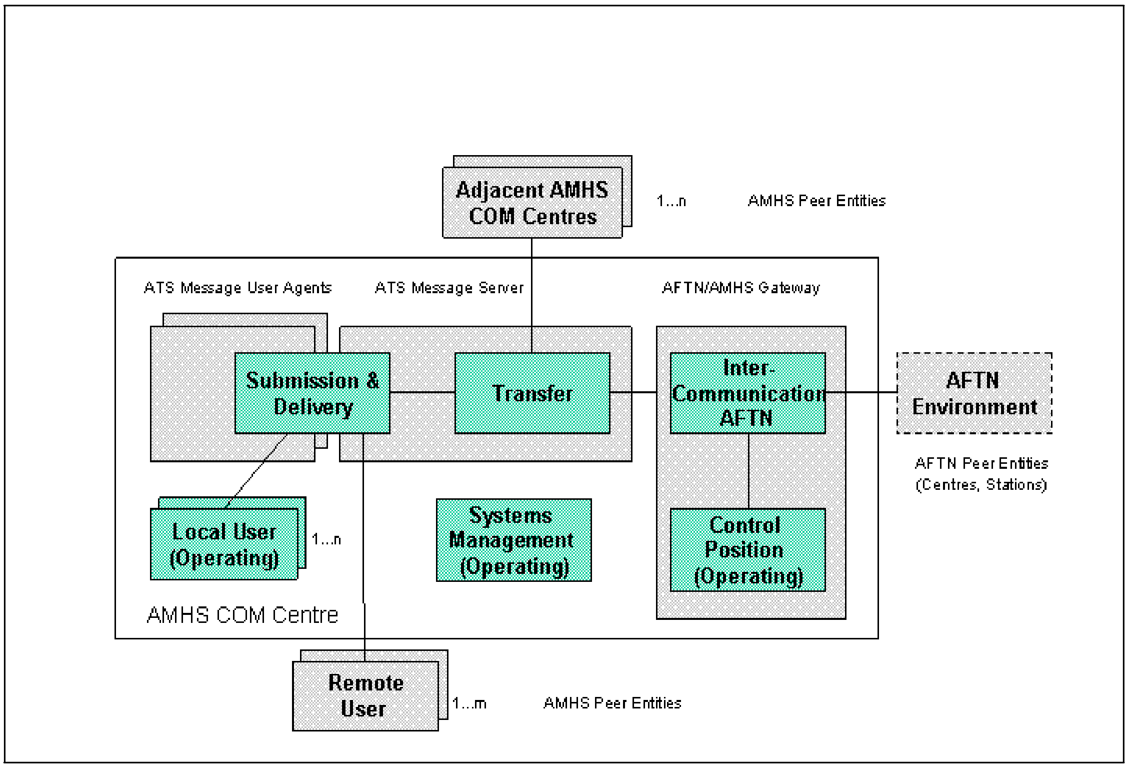

Figure 7: Functional view of an AMHS IUT

7.3.2 AMHS testing phases

7.3.2.1 AMHS Conformance testing

7.3.2.1.1 For the purposes of AMHS, *conformance testing* is considered mandatory and shall be performed in parallel with or after the acceptance testing of a new system.

7.3.2.1.2 The new system is tested as a *black box,* meaning that that required features are verified by observation of the external *behaviour* of the IUT upon stimulation with well-defined input events.

7.3.2.1.3 A *conformance testing equipment,* called the *AMHS test tool,* is used typically for the production of such input events and the monitoring of the resulting outputs from the IUT. In case such an AMHS test tool or reference implementation is *not* available, a test environment could be configured by using functional components of the IUT itself. Testing in such an environment may be seen as consistency testing rather than conformance testing.

7.3.2.1.4 The main AMHS functional areas covered by conformance testing are:

Transfer of messages probes and reports;

Submission of messages and probes / delivery of messages and reports;

Intercommunication with AFTN;

Naming and addressing;

Parameters;

System management functions.

7.3.2.2 AMHS Interoperability testing

7.3.2.2.1 After successful completion of conformance testing, *interoperability testing* is recommended, particularly between AMHS implementations of different manufacturers.

7.3.2.2.2 As a first step to interoperability testing the interconnection between pairs of systems should be established and checked.

7.3.2.2.3 Then, at the bilateral level, the following functional areas should be covered:

Submission, Transfer and Delivery operations (AMHS to AMHS)

Gateway operations (AFTN to AMHS)

Gateway operations (AMHS to AFTN)

Gateway operations (AFTN to AMHS to AFTN)

Gateway operations– special case scenarios

Stress traffic situations

Submission/Transfer/Delivery and Relay operations

Test of special situations

7.3.2.2.4 At the multilateral level, interoperability testing involves more than two organizations, interchanging normal messages and generating specific reactions of their systems.

7.3.2.3 AMHS Pre-operational testing

7.3.2.3.1 Before going into operation, *pre-operational testing* should be carried out between the AMHS systems concerned, within the operational network environment and using duplicated operational traffic.

7.3.2.3.2 The configuration details and the actual sub-sets of traffic to be used, have to be co-ordinated between the test partners. In any case, the operational traffic selected for this purpose should be traffic under the responsibility of the Communication Centres under test.

7.3.2.3.3 The AMHS relation between the two systems is considered operational, if the exchange of the total of operational traffic between them (or a subset of that), is performed by means of AMHS only. For this operational traffic no other transmission means (AFTN or CIDIN) is used.

7.4 Integration to the operational network

7.4.1 A common stepwise transition plan for migrating a successfully tested system into the operational AFTN/CIDIN/AMHS network should be applied.

8 Operational procedures and Recommendations

8.1 Introduction of a new AMHS COM Centre in the AMHS network

8.1.1 Scope of the procedure

8.1.1.1 This procedure specifies the actions necessary to perform the introduction of a new AMHS COM Centre in the International AMHS network. The term "new AMHS COM Centre" may refer to three distinct cases:

the COM Centre already exists. It provides CIDIN and possibly conventional AFTN connectivity, and it supports the AFTN application of the CIDIN for national users. AMHS is introduced as an additional functionality and service in the existing COM Centre. This case corresponds to the majority of COM Centres in the AFI Regions;
the COM Centre already exists. It provides conventional AFTN connectivity. AMHS is introduced as an additional functionality and service in the existing COM Centre.

8.1.1.2 From the above, it results that, strictly speaking, the procedure is related to the introduction of the AMHS operational service in a COM Centre of the international AFTN/CIDIN/AMHS network.

8.1.2 Target AMHS network

8.1.2.1 The target AMHS network which this procedure aims at reaching, when applied to all COM Centres in the AFI/NAT Region, has the following characteristics:

it is an integrated AMHS network, composed of one single AMHS island in which all COM Centres are interconnected;

it is a fully-meshed network, which means that there is an any-to-any connectivity at the level of AMHS connections (associations between MTAs) between COM Centres.

8.1.3 Assumptions

8.1.3.1 The principles of [1] are used for the definition of procedure.

8.1.3.2 The procedure relies heavily upon the use of the ATS Messaging Management Centre, implementing off-line management of AFTN, CIDIN and AMHS.

8.1.4 Qualitative objectives

8.1.4.1 The proposed approach aims at three main goals:

1. to migrate all the flows conveyed over the CIDIN link to the AMHS connection. CIDIN connectivity is not maintained at the end of the transition;

2. to migrate operational flows progressively to the AMHS connection, so as to:

facilitate operational validation (reduce the number/extent of changes at each step, to facilitate the analysis of behaviour/results),

enable easy rollback, in case it would be absolutely needed;

3. to limit impact on COM Centres other than those to which the procedure is applied, to reduce as much as possible inter-Regional co-ordination tasks during transition. Co-ordination will still be needed anyway, making use of the AMC.

8.1.5 General procedure

8.1.5.1 The introduction of a new AMHS COM Centre to the operational AFTN/CIDIN/AMHS network shall be performed in a stepwise manner. Initially, the activation of an operational AMHS connection takes place, after appropriate lower layer connectivity has been implemented and bilateral interoperability testing has been successfully completed. Then progressive migration of AMHS, AFTN and CIDIN traffic to the new connection is performed.

8.1.5.2 The detailed description of this procedure is provided in the ATS Messaging Management Manual (see [12]).

8.2 Recommended default values for international MTA names and passwords

8.2.1 Introduction

8.2.1.1 AMHS implementation requires the setting of the MTA names and passwords for each communication partner (MTA) connected. In a future fully meshed AMHS Network, unique identification of the MTAs would be required. Additionally, the naming should respect the knowledge and experiences of the operator staff, in order to avoid any unnecessary complications in the transition to AMHS.

8.2.1.2 One way to achieve this is to use a scheme, in which MTA names and passwords contain keywords which uniquely identify the MTA and facilitate recognition.

8.2.2 Default values for international MTA names

8.2.2.1 The recommended scheme of MTA names consists of:

the term “MTA”;

the Location Indicator of the MTA location; and

a number (for future extensions if required).

8.2.2.2 All items are separated by a hyphen (hexadecimal 2D). The result is a printable string which can be exchanged in a message without difficulties.

8.2.2.3 This scheme could be used for the national MTA naming as well.

8.2.3 Default values for international MTA passwords

8.2.3.1 Password complications arise because manufacturers deviate in the interpretation of an “empty” password. Some implementations await “nothing”, some hexadecimal 00, others a single “space” character. To avoid misinterpretations during establishment of association(s) all tests could be performed with a common (known) password. Individual secure passwords could be established later, in order to ensure the necessary security of operational AMHS facilities.

8.2.3.2 The recommended scheme of the default password consists of:

the term “ICAO”;

the Location Indicator of the MTA location; and

the specific number of the MTA.

8.2.3.3 All items are separated by a hyphen (hexadecimal 2D). The result is a printable string which can be exchanged in a message without difficulties.

8.2.3.4 By following this scheme, the default passwords of future MTAs can be determined at any time. If there are no other security requirements such a scheme can simplify the integration of new MTAs in a fully meshed AMHS Network topology.

9 Miscellaneous

9.1 Legal Recording in AMHS

9.1.1 Annexes to the Convention on Civil Aviation

9.1.1.1 In an AMHS environment the rules for recording of communication are valid as expressed in Annexes 10 [1] and 11 [2] to the Convention on Civil Aviation, in sections 3.5 and 6 respectively. For easy reference, the pertinent paragraphs are quoted below.

9.1.1.2. A telecommunication log, written or automatic, shall be maintained in each station of the Aeronautical telecommunication service except that in an aircraft station, when using radiotelephony in direct communication with an aeronautical station, need not maintain a telecommunication log. [Annex 10, 3.5.1.1]

9.1.1.3 Telecommunication log, written or automatic, shall be retained for a period of at least thirty days. When logs are pertinent to inquiries or investigations they shall be retained for longer periods until it is evident that they will be no longer required. [Annex 10, 3.5.1.5]

9.1.1.4 Recommendation.— In all cases where automatic transfer of data to and/or from air traffic services computers is required, suitable facilities for automatic recording should be provided. [Annex 11, 6.2.2.3.3]

9.1.1.5 All facilities for direct-speech or data link communications between air traffic services units and between air traffic services units and appropriate military units shall be provided with automatic recording. [Annex 11, 6.2.2.3.7]

9.1.1.6 Recommendation.— All facilities for direct speech or data link communications required under 6.2.2.2.1 [Annex 11] and 6.2.2.2.2 [Annex 11] and not otherwise covered by 6.2.2.3.7 [Annex 11] should be provided with automatic recording. [Annex 11, 6.2.2.3.8]

9.1.1.7 Recommendation.—I n all cases where automatic exchange of data between air traffic services computers is required, suitable facilities for automatic recording should be provided. [Annex 11, 6.2.3.5]

9.1.2 Manual on detailed technical specifications for the Aeronautical Telecommunication Network (ATN) using ISO/OSI standards and protocols

9.1.2.1 In the Manual on detailed technical specifications for the Aeronautical Telecommunication Network (ATN) using ISO/OSI standards and protocols [Doc 9880] the logging provisions for the Basic and Extended ATS Message Handling Service are defined. The AMHS management shall include logging provisions which are defined for the ATS Message User Agent, for the ATS Message Server and for the AFTN/AMHS Gateway. Pertinent extracts from this Manual are presented below for easier reference.

9.1.2.2 AMHS Traffic logging upon origination [Doc 9880, Part II, 2.7]

9.1.2.2.1 An AMHS Management Domain shall be responsible for long-term logging of all messages in their entirety, which are originated by its direct AMHS users, for a period of at least thirty days.

9.1.2.3 Traffic logging requirements at an ATS Message User Agent [Doc 9880, Part II, 3.1.3]

9.1.2.3.1 *Note. – The requirement expressed in 9.1.2.2.1 may be implemented in the ATS Message User Agent.*

9.1.2.4 Traffic logging requirements at an ATS Message Server [Doc 9880, Part II, 3.2.3]

9.1.2.4.1 The ATS Message Server shall perform a long-term logging, for a period of at least thirty days, of the actions taken with respect to every message received at the ATS Message Server, whether from an ATS Message User Agent or from another ATS Message Server, and to every report received or generated at the ATS Message Server.

9.1.2.4.2 For the long-term logging of information related to a message submitted to or received by an ATS Message Server, the following parameters related to the message shall be logged:

a) *message-identifier*;
b) *priority*;
c) *content-type*;
d) *originator-name*;
e) *recipient-name* elements on responsibility list;
f) message-content-size;
g) last element of the *trace-information* (if any);
h) arrival-time or submission-time;
i) transfer destination (if any);
j) transfer time (if any);
k) *this-recipient-name* (if message delivery is performed by the ATS Message Server);
l) *delivery-time* (if any);
m) delivery and/or non-delivery reports generated (if any); and
n) event date/time.

Note. – The responsibility list identifies recipients whose per Recipient Indicator responsibility bit has the abstract-value "responsible".

9.1.2.4.3 For the long-term logging of information related to a report generated or received by an ATS Message Server, the following parameters related to the report shall be logged:

a) *report-identifier*;
b) *subject-identifier*;
c) *actual-recipient-name* elements;
d) *report-type* elements;
e) *report-destination-name*;
f) last element of the *trace-information* (if any);
g) *arrival-time* in the ATS Message Server or generation time;
h) transfer destination (if any);
i) transfer time (if any);
j) *OR-name* of the report recipient (if report delivery is performed by the ATS Message Server);
k) *delivery-time* (if any); and

l) event date/time.

9.1.2.5 Traffic logging requirements at an AFTN/AMHS Gateway [Doc 9880, Part II, 4.3.1]

9.1.2.5.1 The Message Transfer and Control Unit shall perform long-term logging, as specified in 9.1.2.5.2 to 9.1.2.5.5, for a period of at least thirty days, of information related to the following exchanges of information objects with the ATN Component and with the AFTN Component:

a) AMHS message transfer out (to the ATN Component);
b) AMHS report transfer out (to the ATN Component);
c) AMHS message transfer in (from the ATN Component);
d) AMHS report transfer in (from the ATN Component);
e) AFTN message conveyance out (to the AFTN Component);
f) AFTN message conveyance in (from the AFTN Component);
g) AFTN service message indicating an unknown addressee indicator conveyance in (from the AFTN Component); and
h) AFTN service message indicating an unknown addressee indicator conveyance out (to the AFTN Component).

9.1.2.5.2 For the long-term logging of information related to an AMHS Message Transfer In and AFTN message conveyance out, the following parameters, relating to the messages, shall be logged by the Message Transfer and Control Unit:

a) input *message-identifier*;
b) *IPM-identifier*, if any;
c) *common-fields* and either *receipt-fields* or *non-receipt-fields* of IPN (Inter-Personal Notification), if any;
d) action taken thereon (reject with *non-delivery-reason-code* and *non-delivery-diagnostic-code*, convert as AFTN message, convert as AFTN acknowledgement message, splitting due to number of recipients or message length, delivery report generation);
e) event date/time;
f) Origin line of converted AFTN message or service message, if any; and
g) transmission identification of AFTN message(s) or service message(s), if returned by the AFTN Component.

9.1.2.5.3 For the long-term logging of information related to AFTN message conveyance in and AMHS Message Transfer Out, the following parameters, relating to the messages, shall be logged by the Message Transfer and Control Unit:

a) Origin line of AFTN message (or AFTN acknowledgement message);
b) transmission identification of AFTN message or service message, if any;
c) action taken thereon (reject with rejection cause, convert as IPM, convert as RN, AFTN service message indicating an unknown addressee indicator generation);
d) event date/time;
e) *MTS-identifier*, if any; and
f) *IPM-identifier*, if any.

9.1.2.5.4 For the long-term logging of information related to an AMHS Message Report In and/or AFTN Service Message indicating an unknown addressee indicator conveyance out, the following parameters, relating to the report and/or service message, shall be logged by the

Message Transfer and Control Unit:

a) *report-identifier* (if report in);
b) *subject-identifier* (if report in);
c) action taken thereon if report in (discard, convert into AFTN service message);
d) event date/time;
e) Origin line of converted AFTN service message (if service message out);
f) Origin line of subject AFTN message (if service message out and no report in); and
g) transmission identification of AFTN message or service message, if any.

9.1.2.5.5 For the long-term logging of information related to an AFTN Service Message indicating an unknown addressee indicator conveyance in and/or to an AMHS Message Report Out, the following parameters, relating to the service message and/or report, shall be logged by the Message Transfer and Control Unit:

a) Origin line of converted AFTN service message (if service message in);
b) Origin line of subject AFTN message (if service message in);
c) transmission identification of AFTN message or service message, if any;
d) action taken thereon if AFTN service message in (discard, convert into AMHS report);
e) *report-identifier* (if report out);
f) *subject-identifier* (if report out); and
g) event date/time

9.1.2.5.6 If, for any reason, the processing of the AMHS component cannot be properly achieved, the procedure shall unsuccessfully terminate and:

1) logging of the error situation and reporting to a control position, and

2) storage of the concerned message for appropriate action at the control position,

shall be performed.

Note. – ICAO Doc 9880, Part II [3] specifies all cases for the AFTN/AMHS Gateway in more detail.

9.2 Institutional / financial issues

- to be developed -

Attachment A: Change Control Mechanism of the AFI AMHS Manual and its Appendices .

Note. – Changes, problems or defects detected concerning the Standards and Recommended Practices (SAPS) summarised in the ICAO Documentation (Doc 9880 as well as Doc 9537) are not affected by this mechanism. For these documents the change control process set up by ACP and its Working groups, by using PDR (Preliminary Defect Reports) applies.

Proposals to introduce changes to the AFI AMHS Manual and its Appendices may arise from users, implementers or manufacturers. The procedure for submission and processing of a Defect Report (DR) or a Change Proposal (CP) involves the following steps:

A.1 Procedure for DR

a) A problem is detected concerning the operation of the AMHS network, which is reflected in the AFI AMHS Manual and may be attributed to implemented AMHS procedures and/or inconsistencies in the documentation.

b) The problem is reported to the: Decided from the AFI Strategy and Implementation Plan.

A.2 Procedure for CP

The same structured procedure, with the exception of steps (f) and (g) applies in case of proposed enhancements to the AFI AMHS Manual or inconsistencies in existing AFI AMHS documentation.

In this case, a change proposal (CP) should be submitted to the PG. The format of the CP is similar to that of the DR.

(If Doc 9880 documentation is concerned the change control process set up by ACP and its Working groups has to be followed (see Attachment B).)

A.3 Template for Defect Reports / Change Proposals

TEMPLATE FOR DEFECT REPORTS / CHANGE PROPOSALS

DR_____ **CP_____**

Title:	Short, indicative textual name
Reference:	Number assigned by the PG
RapportAFI **Originator reference:**	Provided by the originator
Submission date:	
Submitting State/Organization:	

Author:	
Contact Information:	e-mail, fax, telephone and postal address
Experts involved:	
Status:	Assigned by the PG RapportAFI
Priority:	Assigned by the PG RapportAFI
Document reference:	Affected section(s) of the AFI AMHS Manual or its Appendices
Description of defect:	Nature of the problem in detail Reason(s) for requesting changes
Assigned expert(s):	
Task history:	Working Papers and Information Papers Produced on the subject
Proposed solution:	Including amendments to the text, if feasible

DR/CP STATUS control sheet				
Event	**Date**	**Status**		**Remark**
DR or CP received submission date		Set to submitted		
discussion at PG/ ...		Set to accepted	Set to rejected	
Date for development of proposals/ solutions				Responsible:
discussion at PG/ ...		Set to resolved		
presentation to AFSG/ ...		Set to adopted	Set to rejected	
Date for development of amendment to the Manual				Responsible:
discussion at PG/		Set to approved		
presentation to ICAO		Set to approved for application		
Additional DATES and comments				

Attachment B: Amendment Procedure for the detailed Technical Specifications for Air/Ground and Ground/Ground Data Links

(updated 2008-06-12)

Published in the Report of the twelfth meeting of the Aeronautical Communications Panel (ACP), Working Group M (WG M) -(Reconstituted), Montreal, 16-19 June 2008

B.1 Introduction

B.1.1 Detailed technical specifications for air/ground and ground/ground data link systems are contained in the following ICAO documents:

ATN/OSI	Doc 9880, Manual on detailed technical specifications for the Aeronautical Telecommunication Network (ATN) using ISO/OSI standards and protocols
ATN/OSI	Doc 9705, Manual on technical provisions of the aeronautical telecommunication network (to be withdrawn)
ATN/OSI	Doc 9739, Comprehensive Aeronautical Telecommunication Network (ATN) Manual (to be withdrawn
AMS(R)S	Doc AMSRS, Manual for Aeronautical Mobile Satellite (Route)_Service
VDL Mode 2	Doc 9776, Manual on VHF Digital Link (VDL) Mode 2
VDL Mode 3	Doc 9805, Manual on VHF Digital Link (VDL) Mode 3 (currently not being maintained)
VDL Mode 4	Doc 9816, Manual on VHF Digital Link (VDL) Mode 4
HF data link	Doc 9741, Manual on HF Data Link

B.2 Amendment Procedure

B.2.1 ACP Working Group M (WG M) will continue to maintain the material identified in section B.1.1 as indicated in the terms of reference agreed in ACP. In this task, the working group will consider proposals for amending this material as a result of ongoing validation of the detailed technical specifications and experience gained during the implementation of these systems. Amendments are necessary when a statement of information in the manuals or their supporting material, if not corrected, will prevent the system from meeting its stated operational requirements.

B.2.2 Amendment Proposals will be submitted to ACP Working Group M, preferably in the format of Table B-2. ACP Working Group M will review each amendment proposal and agree on the changes, to be made to the relevant detailed technical specifications. The amendment proposals will be distributed to the members of WG M by the secretariat through placing the information on the ACP website. This would also enable all panel members to also consider the proposals.

B.2.3 Amendment Proposals may be required when:

i. implementation hardships occur, resulting from schedule and/or costs;

ii the detailed technical specifications over-specify the actual requirements for achieving interoperability or may unnecessarily constrain implementation or further development;

iii the detailed technical specifications inadequately specify the actual requirements for achieving the intended operational capabilities;

iv ambiguities in the detailed technical specifications result in different implementations that are not interoperable;

v interoperability discrepancies are discovered.

Note.- Should a State [or a relevant international organization] identify a safety critical problem, which might e.g. necessitate grounding of aircraft, an ICAO fast track procedure should be established. Such a procedure would enable an amendment of the SARPs at very short notice (e.g. 1 - 2 months). A fast track procedure is not expected to be required for detailed technical specifications.

B.3 Maintenance procedures

B.3.1 The following maintenance procedures apply:

i interested parties submit an amendment proposal, preferably using the form in Table B-2. The proposal will address aspects relating to the backwards compatibility of the amendment proposal. The proposal will also indicate a category from Table B-1 and identify a coordinator.

ii the amendment proposals will be placed on the ACP website as soon as practicable;

iii WG M will consider amendment proposals will be submitted not later than four weeks prior to a WG M meeting;

iv the amendment proposal will be reviewed during meetings of WG M. If necessary, a special group will be formed to study detailed aspects of the proposal. If the working group cannot complete its re view, the amendment proposal will be added to the list of action items.

v the Working Group M will recommend to ICAO on the amendments necessary;

vi ICAO will publish regularly the necessary amendments to the manuals on detailed technical specifications and implementation aspects.

Table B-1 Category of an Amendment Proposal (AP)

Category	**Description**
Critical	The AP addresses a serious flaw in the manuals text which either: a) if implemented in an operational system could jeopardize safety in the air, and/or b) would result in non-interoperability between operational systems which have implemented the amendment proposal and those which have not.
Bug	The AP addresses bugs in the manuals, which affect SARPs, and/or operational implementations to be fully compliant with the technical provisions in the manuals.
Clarification	The AP clarifies an ambiguity or omission in the manuals. APs in this category are useful but not essential to ensure interoperability and proper functioning of the system.
Minor	The AP clarifies or improves the internal consistency of the manuals, but has no effect on implementations.
Editorial	The AP corrects one or more editorial or typographical errors in the manuals, or adds detail, which has no effect on implementations.
Registration	The AP proposes placeholders for activities other than those identified in the manuals.

Table B-2 Format of an Amendment Proposal (AP)

Title:	
AP working paper number and date:	
Document(s) affected:	Doc 9880, Manual on detailed technical specifications for the Aeronautical Telecommunication Network (ATN) using ISO/OSI standards and protocols Doc AMSRS, Manual for Aeronautical Mobile Satellite (Route) Service Doc 9776, Manual on VHF Digital Link (VDL) Mode 2, Doc 9816, Manual on VHF Digital Link (VDL) Mode 4 Doc 9741, Manual on HF Data Link
Sections of Documents affected:	
Coordinator:	
Coordinators address:	
Coordinators Phone:	
Coordinators Fax:	
Coordinators e-mail address:	
Category:	CRITICAL I BUG I CLARIFICATION I MINOR I EDITORIAL I REGISTRATION
Problem description:	
Background:	
Backwards compatibility:	
Amendment Proposal:	
WG-M status:	PROPOSED I APPROVED I PENDING I REJECTED

-END-