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ACCESS

ATN Compliant Communications

European Strategy Study

Interim Deliverable 4

ATSMHS Interoperability/Conformance Testing

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0.2	3rd March 1999	Second Draft: incorporates STNA comments
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2.0	16 April 1999	Final Issue: note added to section 3.3 point 3 and resolution of field code problem.

EXECUTIVE SUMMARY

This document is ACCESS Interim Deliverable 4 and contains a summary of the work packages completed under ACCESS phase 2 - Part 2 of the project covering ATSMHS Interoperability/Conformance Testing.

The objectives and scope of the interoperability testing are defined and ATSMHS operating scenarios are provided which meet these objectives and allow the testing of any given component in an AMHS. Altogether, fifty scenarios are described which cover both normal and abnormal conditions to which the components may be subjected.

The Equipment and facilities necessary to implement the ATSMHS interoperability testing operating scenarios are defined. The test equipments required are largely off-the-shelf products, most of which would be procured with a gateway or would be readily available anyway. A total of 44 man days is estimated for the time required to develop the test scripts and configuration files.

A test list and a detailed test specification have been developed. The list of the interoperability tests proposes a description of each test with a high level definition to give the general purpose of a given test. This list should facilitate the execution of the tests as well as the analysis of the test results. The specification of the interoperability tests implies the accurate description of the test itself by showing the role of each functional element of the test configuration. Each object used to perform the test is presented as well as its behaviour during the test execution. Finally the Expected results are given.

A notional test schedule has been developed in order to plan the execution and to estimate the duration of the tests. The sequence given to perform the tests has been established to facilitate the linking, to minimise manipulations in order to minimise possible configuration errors and finally to reduce the global test performance duration. A number of assumptions have been made leading to a final estimate of test execution duration of up to 13 days for 2 people, one in each site.

The possible use of test tools is examined and a number of recommendations are made. Firstly, the benefits which might be gained through the use of automated test tools could be highly beneficial in the AMHS interoperability testing environment. The recommended subset of services consists of:

- interact with test database
- support the test operators in controlling test execution
- communicate with remote test operators
- generate test data from test cases
- support test operator in recording test results
- maintain test case database
- maintain test results database
- generate test reports.

Concerning the implementation of these services, it is recommended that the test tools consist of one central computer installation with remote access by test operators. A list of functional and non-functional requirements placed on the system is given.

This report also considers conformance testing where it is shown that conformance testing is particularly relevant to the AFTN/AMHS Gateway with a possibly high cost/benefit ratio.

The AFTN/AMHS Gateway, as a component of the AMHS, is described briefly from the viewpoint of conformance testing. It is shown that, in particular, the conversion functions corresponding to the so-called "Message Transfer and Control Unit" are the ones which should be subject to conformance testing.

In order to make recommendations for conformance testing the AFTN/AMHS Gateway, conformance testing in two other contexts, OSI and CIDIN is described. The degree to which the testing should be able to "look into" the Gateway being tested is also considered. A discussion on the options from an organisational and equipment point of view provides further background.

Concerning the overall conformance testing strategy, three sets of recommendations are made:

- organisational arrangements should foresee, amongst other things, testing being performed by individual equipment providers and States using a common set of test suites which are maintained centrally;
- the Gateway should be tested as a "black box" on its external interfaces only;
- the availability of common test equipment or at least equipment conforming to common specifications is desirable. A set of high level requirements placed on Gateway conformance testing equipment is given.

A list of conformance tests is derived from an analysis of the relevant SARPs and 11 different test areas are identified. Examples of test specifications are provided in this document from each of the test areas together with descriptions of AFTN and AMHS default PDUs and IUT configured parameters.

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1. Introduction

1.1 Background

Part 2 of the ACCESS Study addresses ATSMHS Interoperability/Conformance Testing and consisted of nine Work Packages (WP260-WP266, WP270-WP271) as detailed in the 'References' section below. These Work Package deliverables provide a framework for the establishment and conduct of interoperability trials between two or more ATSMHS equipments and for specific conformance testing activities on individual ATSMHS equipments.

During the initial planning of the ACCESS Project it was anticipated that systems suitable for ATSMHS interoperability/conformance testing would be developed during the project timeframe as a result of national planning activities and as a result of Eurocontrol initiatives (e.g. Eurocontrol Communications Gateway - ECG project). A minimum of two independently developed systems were required for effective interoperability testing. However, the subsequent timing changes to these activities has meant that such testing would not be possible during the timeframe of the ACCESS Project. It was therefore decided to complete the work to define ATSMHS Interoperability/Conformance testing and to postpone the completion of testing activities until such time as sufficient systems become available. Therefore the work completed under Part 2 of the ACCESS project describes interoperability and conformance test environments which can be used by States or other organisations as the basis for testing. This preparatory work will expedite the launch of such trials in the future.

1.2 References

Reference	Title
[A260]	Define Trials Objectives Version Dated
[A261]	Define Operating Scenarios Version Dated
[A262]	Produce Test Specification Version Dated
[A263]	Produce Test Schedule Version Dated
[A264]	Define Interoperability Test Tools Version Dated
[A265]	Configure Trials Scenario Version Dated
[A266]	Conduct ATSMHS Trials Version Dated
[A270]	Conformance Test Requirements Version Dated
[A271]	Conformance Test Specification Version Dated
[ICAO1]	ICAO, Aeronautical Telecommunications Network (ATN), Standards and Recommended Practices (SARPs), Sub-Volume 3, Ground-Ground Applications, Version 2.2, January 1998
[ICAO2]	Guidance Material on [ICAO1]

2. Conformance versus Interoperability Testing

The primary objective of the ATSMHS Interoperability Testing is to confirm the end-to-end interoperability of two AMHS systems, which have both been developed to a common specification. This testing approach is distinct from other techniques such as conformance testing and reference testing.

Conformance testing can be defined as the exhaustive testing of a system under test against the functions and procedures defined in an agreed standard. A rigorous approach would test all the 'shall' and 'should' statements in the design specification.

Reference testing is defined as the recording of responses from the reference system under test during a pre-determined set of test situations - typically in a test harness. The reference system under test is then removed and stored. Future 'Systems Under Test (SUT) should then produce the same results as the reference system when exposed to the same test situations. A reference test may contain some elements of conformance testing, but the tests need not be completely exhaustive.

As an extension of this definition, Table 1 is intended to show, in an informal way, the major differences between interoperability and conformance testing.

	conformance testing	**interoperability testing**
major goal of testing	demonstrate conformance with respect to specification	demonstrate capability of correctly interworking with other systems
scope of tests	as far as possible, all clauses of the specification ("shall" and "should" statements) are tested	realistic interactions which could occur in a real network are tested
sequence of testing activities	normally performed on a system first	sensible only with systems which have already been conformance tested
other systems in test environment	dedicated, purpose-built test equipment	real production systems, possibly with test support equipment
number of systems involved	one system under test and testing equipment	system(s) under test and other comparable systems
distribution of test locations	can be performed locally between system under test and test equipment, e.g. in a laboratory	normally distributed over at least two remote locations
importance of incorrect protocol behaviour	handling of incorrect protocol behaviour by SUT is deliberately tested	only limited test possibilities are available because of the use of real systems

Table 1: Distinctions between conformance and interoperability testing

The distinction is illustrated in a schematic way in Figure 1. In the case of interoperability testing, the "other production systems" should ideally consist of parts of the real operational AFTN and AMHS.

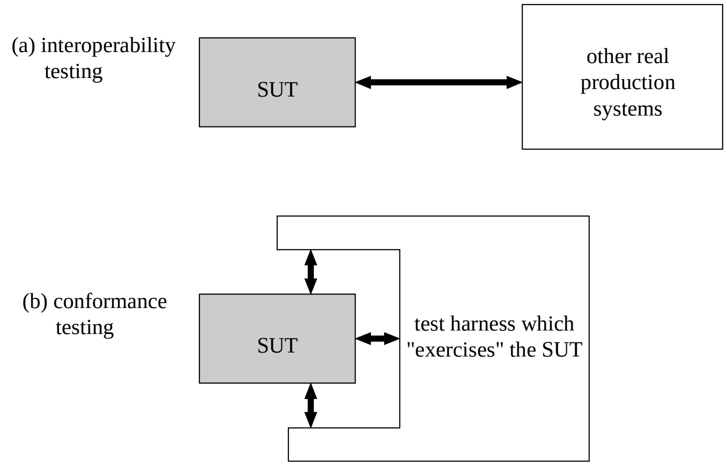

Figure 1: Schematic distinction between interoperability and conformance testing

It is clear that the type of testing performed during conformance testing is basically different from that of interoperability testing. In particular, in conformance testing

- some test sequences can be performed which would not be possible within the scope of interoperability testing, thus exercising the full scope of the specification,
- whereas performance and load testing are possible, at least in principle in interoperability testing, this is not usually considered in conformance testing which is restricted to the ”logic” of the protocol implementation,
- individual layers, components and interfaces of the SUT might be considered individually whereas this is never the case in interoperability testing.

3. INTEROPERABILITY TESTING

3.1 Introduction

The primary objective of the ATSMHS Interoperability Testing is to confirm the end-to-end interoperability of two AMHS systems, which have both been developed to a common specification.

3.2 Scope of Testing

The scope of the ATSMHS Interoperability Trials is limited to the ATS Message Handling System (AMHS), i.e. to the provider of the ATS Message Service as defined in the ATSMHS SARPs. Since there are no plans in Europe to support the ATN Pass-Through Service, nor to implement any AFTN/ATN Type A Gateway, such systems are out of the scope of the ATSMHS Interoperability Trials defined in ACCESS.

To achieve the above objectives, the Interoperability Trials should cover the following aspects of interoperability testing:

a) protocol testing, encompassing X.400 to X.400, X.400 to AFTN, AFTN to X.400 and AFTN to AFTN interoperability[1], and covering both message transmission and resultant acknowledgements;

b) functionality testing, to ensure the appropriate implementation of X.400 and/or AFTN functionality and services, and the correct mapping between X.400 and AFTN functions[2] (e.g. X.400 distribution lists and AFTN meteorological data, System to System and Flight Planning services), including rejection of messages that cannot be mapped (e.g. invalid content or body part type, invalid ATS message);

c) resilience testing, particularly with regard to the recovery of communicating messaging systems and incomplete message transfers following system or network failure;

d) performance testing, to ensure that the AMHS messaging systems under test are capable of meeting the message throughput required to support the agreed end-to-end service levels[3];

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[1] Note that network protocol interoperability is not be explicitly tested. There is however be an implicit testing of network protocol interoperability during the interoperability testing of the X.400 and AFTN messaging protocols. ATN compliant network services should be used to support the Interoperability Trials wherever possible.

[2] Because of the limited functionality of AFTN compared to X.400, X.400 users will initially be restricted to the use of AFTN compatible functions (i.e. the 'basic service'). There is however work planned for the future which will consider the exploitation of additional X.400 features, which may impact future requirements for interoperability testing. Since this study will not complete within the timeframe for the ACCESS project, only the 'basic service' is covered by the Interoperability Testing.

[3] Performance levels could be defined prior to testing or local targets could be set which would allow some confidence to be gained in the ability of the implementation to function under load.

e) control and monitoring service testing, to ensure that the appropriate management functions and interfaces are available to support the required message tracing and audit trail services;

f) addressing scheme testing, to ensure the full and open interoperability of AFTN and X.400 users.

Note that security testing will not be possible until the ongoing study into a general migration to ITU-T X.500 compliant security services, particularly to support authentication, has completed. The X.500 study is not scheduled to complete within the timeframe of this project.

3.3 Interoperability Interfaces

Figure 2 illustrates the interfaces to be tested within the scope and objectives of the Interoperability Trials.

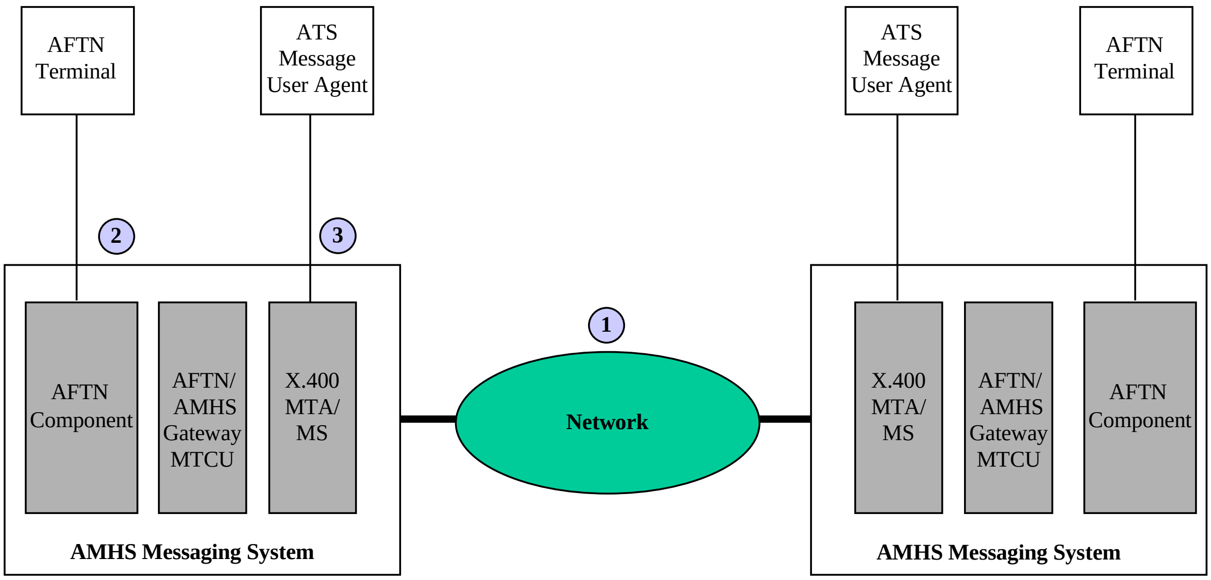


Figure 2: Interoperability Interfaces

It can be seen from Figure 2 that the following interfaces will be tested:

1. The X.400 (P1) interface between the AMHS messaging system under test and the remote system.

2. The AFTN terminal interface to the AMHS messaging system.

3. The X.400 (P7) terminal interface to the AMHS messaging system (Note: this interface is strictly a local implementation matter but protocol P7 is suitable for this use).

It should be noted that the AFTN and ATS Messaging User Agent terminals used to generate and receive messages to/from the AMHS messaging system are outside of the scope of the Interoperability Trials. Were they to be considered to form part of end-to-end interoperability testing, then all terminals supported by a particular message switch would have to be tested. However, since such terminals will be required to exercise the AMHS messaging system, it is important that stable and (where available) widely used terminal products are used for this purpose.

3.4 INTEROPERABILITY SCENARIOS

The ATSMHS component functions identified in the ATSMHS SARPs [ICAO1] are as follows:

- AFTN/AMHS Gateway, hereafter called a “Gateway”
- ATS Message Server, hereafter called a “Message Server”
- ATS Message User Agent, hereafter called a “User Agent”

When an organisation procures a component of the AMHS, it will be required to perform interoperability tests with other components with which it will be required to inter-operate. The component is known as the implementation under test (IUT).

There will be cases where the IUT performs the functions of more than one component. For example, a single component may have the functionality of both a message server and a gateway. Where this situation occurs, the tests for both components will have to be combined.

Situations will occur where two components will be tested at the same time. The first interoperability tests will, of course, be in this situation. In such cases, it will be possible to merge the tests. For example, the test that checks that a message can be sent from a gateway to another will also act as a test that the other gateway can receive a message.

Each scenario has a reference number to provide for traceability back to the trials objectives, and to allow the test specifications to provide for traceability to the operating scenarios. The reference number has three fields, e.g. OSC-XX-nn where:

- OSC - Operating scenario
- XX - identifies the type of IUT - GW for a gateway, MS for a message server and UA for a user agent
- nn - is a serial number

Section 3.4.5 provides an example of how a matrix can be used for tracing test scenarios back to the trials objectives.

Strictly speaking, some of the scenarios are not interoperability tests, since they are only local tests, and do not involve a remote system. In any given situation, it may or may not be appropriate to use these scenarios as a basis for testing. These local tests perform a test on the functionality of the IUT that does not involve communication with a remote system.

It should also be noted that there are scenarios included that are designed to test performance. It is not possible to define the required performance level in this document. When an implementation is established, it will be necessary to define the required performance level of that particular implementation. For example, a major node in the messaging network will have a much higher performance requirement than a small system serving only a few users. Performance tests will have to be performed against the required level of performance for the given implementation.

3.4.1 Gateway Scenarios

This section defines operating scenarios that can be used as a basis for tests for a gateway that conforms to the ATSMHS SARPs [2]. Figure 3 and Figure 4 show the two configurations used for the gateway scenarios. The configuration that should be used depends on the type of systems that are on the remote site:

- if the remote site has a gateway and no message server functionality, then configuration 1 is all that is required;
- if the remote site has a message server but no gateway functionality, then configuration 2 is all that is required;
- if the remote site has both message server and gateway functionality, then both configurations are needed, and the tests will have to be run against both configurations separately.

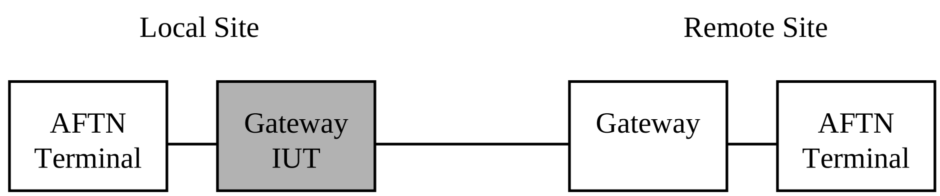


Figure 3: Configuration 1 - gateway to gateway

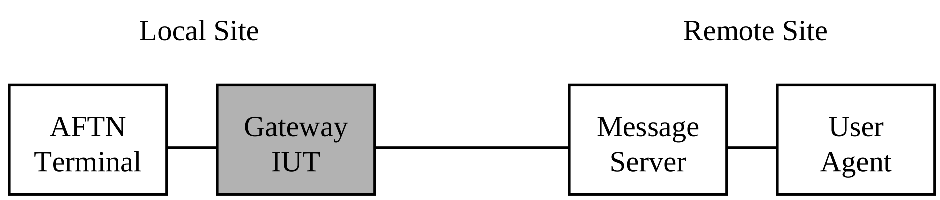


Figure 4: Configuration 2 - gateway to message server

It should be noted that some tests are appropriate to both configurations, whereas some are only appropriate to one configuration. For example, in configuration 1 it is possible to test that the translation methods of the two gateways are compatible, since the resulting AFTN message should be the same as the original AFTN message. However it is not possible, under configuration 1, to check that the translation performed is conformant with the translation required by the ATSMHS SARPs. On the other hand, in configuration 2 it is possible to check that the translation has been performed correctly.

3.4.2 Message Server Scenarios

This section defines operating scenarios that can be used as a basis for tests for a message server that conforms to the ATSMHS SARPs [2]. Figures 5, 6 and 7 show the three configurations used for the message server scenarios. The configuration that should be used depends on the testing and type of systems that are on the remote site.

- if the remote site has a gateway and no message server functionality, then configuration 3 is all that is required
- if the remote site has a message server but no gateway functionality, then configuration 4 is all that is required

- if the remote site has both message server and gateway functionality, then both configurations are needed, and the tests will have to be run against both configurations separately

- for testing the user agent to message server functionality the local only configuration 5 is all that is required.

The presence of a distribution list is only necessary when performing the distribution list tests.

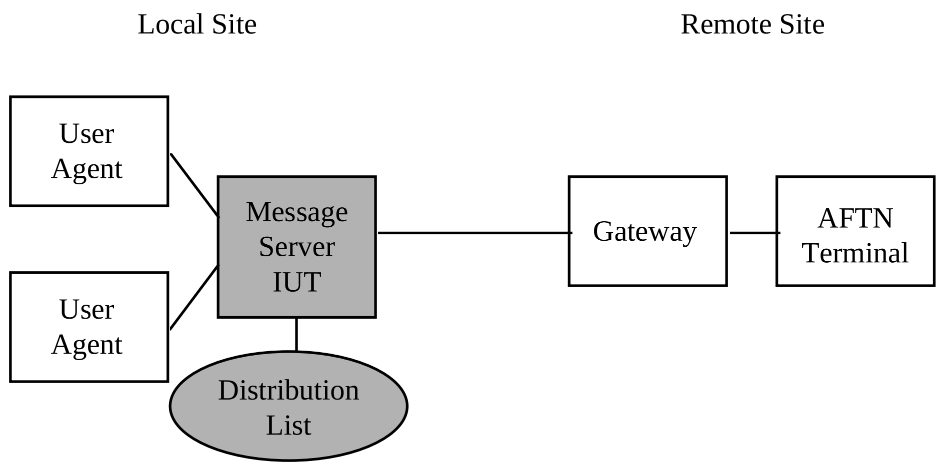


Figure 5: Configuration 3 - message server to gateway

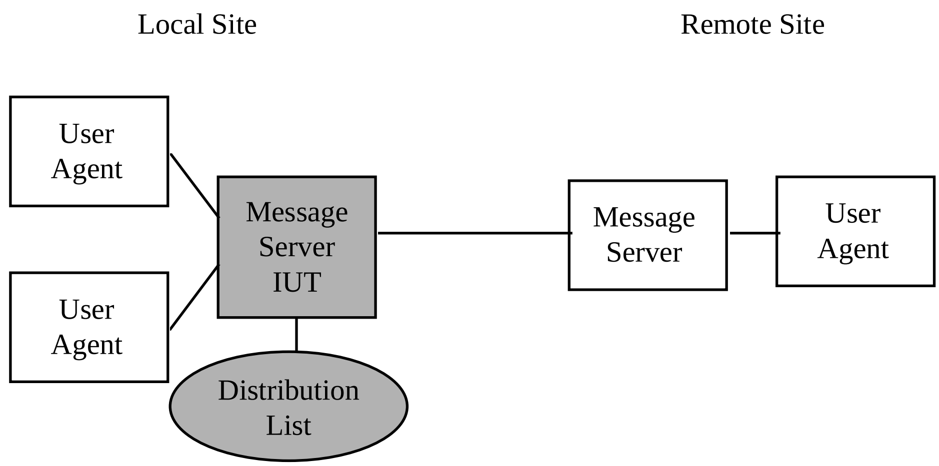


Figure 6: Configuration 4 - message server to message server

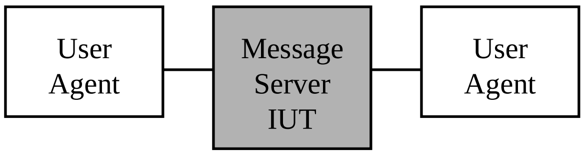


Figure 7: Configuration 5 - user agent to message server

3.4.3 Trials Equipment and Facilities Requirements

Table 2 is an inventory of equipment, communication requirements and specific test tools that will be required to conduct the tests

Item	***Description***	***Required if IUT is a:***			***Special development required?***
		Gateway	***Message Server no MS***	***Message Server and MS***	
IUT	The Implementation Under Test.	X		X	This should be part of the procured equipment configuration.
AFTN terminal	An AFTN terminal will be needed as the source and sink of the tests. In order to allow the tests to be scripted, the AFTN terminal should be capable of taking instructions from pre-prepared batch files.	X			This should be part of the procured equipment configuration.
UAs	Two UAs will be needed as the source and sink of the tests. In order to allow the tests to be scripted, the UA should be capable of taking instructions from pre-prepared batch files. The second UA is not required for all tests.		X		This should be part of the procured equipment configuration.
Remote UA	A Remote UA will be needed as the source and sink of the tests of the Message Server Message Store.			X	This should be part of the procured equipment configuration.
Local AFTN terminal Communication	Communication between the AFTN terminal and the IUT will be done through a LAN or serial line connection (depending on the facilities available on the IUT).	X			This should be part of the procured equipment configuration.
Local UA Communications	Communication between a UA and the IUT will be done over a LAN		X		

Item	***Description***	***Required if IUT is a:***			***Special development required?***
		Gateway	***Message Server no MS***	***Message Server and MS***	
Remote UA Communications	Communication between the Remote UA and the IUT will be done over a LAN or WAN(preferably ATN Internet if available) connection. . Depending on the capabilities of the Remote UA and IUT			X	
Remote Communication	Communication between the IUT and the remote system will be through an ATN WAN connection. Depending on the capabilities of the IUT, an ATN router will probably be required on the LAN.	X	X		This should be part of the procured equipment configuration.
Configuration files for IUT	For each test to be performed, the IUT will have to be pre-configured for the test. The configuration files may be prepared in advance to speed up the testing process.	X	X	X	The pre-configured files must be developed.
Configuration files for AFTN terminal	For each test to be performed, the AFTN terminal may have to be pre-configured for the test. The configuration files may be prepared in advance to speed up the testing process.	X			The pre-configured files must be developed.
Configuration files for User Agent	For each test to be performed, the UA may have to be pre-configured for the test. The configuration files may be prepared in advance to speed up the testing process.		X	X	The pre-configured files must be developed.
Configuration 1	A gateway and two AFTN Terminals will be required.	X			If not pre-existing systems they should be part of the procured equipment configuration.
Configuration 2	A Message Server, one User Agent and one AFTN Terminal will be required	X			If not pre-existing systems they should be part of the procured equipment configuration.

Item	***Description***	***Required if IUT is a:***			***Special development required?***
		Gateway	***Message Server no MS***	***Message Server and MS***	
Configuration 3	A gateway, one AFTN Terminal and two User Agents will be required.		X	X	If not pre-existing systems they should be part of the procured equipment configuration.
Configuration 4	A Message Server and three User Agents will be required		X	X	If not pre-existing systems they should be part of the procured equipment configuration.
Configuration 5	Two local or remote User Agents will be required		X	X	If not pre-existing systems they should be part of the procured equipment configuration.
Scripted tests	All the tests should be run through scripts. This will ensure that • there is consistency between one set of interoperability tests and another; • it is certain that a repeated test is exactly the same as the initial test; • the exact sequence of inputs can be checked in the case of test failure.	X	X	X	The scripted tests must be developed.

Table 2: Trials Equipment and Facilities Requirements

3.4.4 Development Effort

This section provides an estimate of the development effort required to produce test scripts and configuration files. The ATSMHS Interoperability Test Specification will define the requirements for the configuration of the different systems as well as for the test scripts.

The ATSMHS Interoperability Trials Operating Scenarios indicate the approximate number of tests to perform for each type of IUT. That is:

- for gateways - approximately 25 test scenarios, and 2 configuration files (gateway and AFTN terminal);
- for message servers - approximately 25 test scenarios, and 2 configuration files (message server and user agent);

In setting budgetary estimates for the time required to create the test scripts, the following assumptions have been made:

- learn the scripting language - 3 days
- generate test cases - 3 test cases per day
- review and correction of test cases - 3 test cases per day
- learn the structure of the configuration files and develop the required test structure - 1 day

Also assuming that the scripting language and configuration file formats are different for each type of IUT, the learning process will have to be duplicated. (This is the worst case scenario.) Rounding up the time to the nearest whole day, the following estimates can be made for the budgetary effort required for developing test scripts and configuration files:

- gateway - 22 days
- message server - 22 days

These estimates are for a single site. Initially, two systems will be tested against each other; this will double the estimate. It should be noted that this is a worst case scenario. In practice, much of the work will be duplicated, and so the effort can be reduced. For example, in practice the test script language used for one system may be the same as the test script language used for another. Thus the learning effort required will be reduced. Several scenarios may be combined into one test case.

3.4.5 Traceability Matrix

Table 3 provides an example of a traceability matrix which lists each test scenario against the testing objectives.

Scenario	Protocol	Functional	Resilience	Control and Monitoring	Addressing	Performance
Gateway Scenarios						
OSC-GW-01	X	X		X	X	
OSC-GW-02	X	X		X	X	
OSC-GW-03	X	X		X	X	
OSC-GW-04	X	X		X	X	
OSC-GW-05	X	X		X	X	
OSC-GW-06	X	X		X	X	
OSC-GW-07	X	X		X	X	
OSC-GW-08	X	X		X	X	
OSC-GW-09	X	X		X	X	
OSC-GW-10	X	X		X	X	
OSC-GW-11	X	X		X	X	
OSC-GW-12	X	X		X	X	
OSC-GW-13			X	X		X
OSC-GW-14	X	X	X	X		
OSC-GW-15		X	X	X		
OSC-GW-16		X		X	X	
OSC-GW-17		X		X	X	
OSC-GW-18	X	X		X	X	
OSC-GW-19	X	X		X	X	
OSC-GW-20	X	X		X		
OSC-GW-21	X	X		X		
OSC-GW-22	X	X		X		
OSC-GW-23	X	X		X		
OSC-GW-24	X	X		X		
OSC-GW-25	X	X		X		
Message Server Scenarios						
OSC-MS-01	X	X		X	X	
OSC-MS-02	X	X		X	X	
OSC-MS-03	X	X		X	X	
OSC-MS-04	X	X		X	X	
OSC-MS-05	X	X		X	X	
OSC-MS-06	X	X		X	X	
OSC-MS-07			X	X		X
OSC-MS-08	X	X		X	X	
OSC-MS-09	X	X		X	X	
OSC-MS-10		X		X	X	

Scenario	Protocol	Functional	Resilience	Control and Monitoring	Addressing	Performance
OSC-MS-11		X		X	X	
OSC-MS-12	X	X		X	X	
OSC-MS-13	X	X		X	X	
OSC-MS-14	X	X		X	X	
OSC-MS-15	X	X		X	X	
OSC-MS-16	X	X				
OSC-MS-17	X	X				
OSC-MS-18	X	X				
OSC-MS-19	X	X				
OSC-MS-20	X	X		X	X	
OSC-MS-21	X	X		X	X	
OSC-MS-22	X	X		X		
OSC-MS-23	X	X		X	X	
OSC-MS-24			X	X		
OSC-MS-25			X	X		

Table 3: Example of Traceability Matrix

3.5 Test Specification

3.5.1 Tests Specification List

Each test is identified by a reference with the following format.

The reference numbers used for each test are based on the reference numbers attributed for the Interoperability Operating Scenarios. Thus each reference test has 5 fields:

- OSC - Operating Scenario
- XX - identifies the type of IUT - GW for a Gateway, MS for a Message Server and UA for a User Agent
- nn - is a serial number which qualifies the Operating Scenario reference (Range from 1 to 50)
- CT - C for Configuration T for Test
- ct - serial number referencing the test: « c » corresponding to the type of configuration (Range from 1 to 5) ; « t » referencing the test itself.

3.5.1.1 Example Gateway Test List Format

Sending a priority two message from a gateway to the remote system

Test n°:	OSC-GW-01-CT-11

Test Type:	Send a message from the Local AFTN site with a DD priority to the Remote AFTN site.

3.5.1.2 Example Message Server Test List Format

Outgoing IPM Transfer

Test n°:	OSC-MS-01-CT-31
Test Type:	Send a valid AMHS message from the Local site to a valid AFTN addressee in the Remote site.

3.5.2 Tests Specification Details

Each test specification is a sub set of an Operating Scenario.

Each test specification is composed of 4 fields :

- Test n°:
- Test Type:
- Description:
- Expected results:

The content of the « Test n°: » field is as described above concerning the meaning of the figures and letters used.

The content of the « Test Type: » field is the same as the corresponding one in the « test list » description.

The content of the « Description: » field is a brief description of the elements (Originators, Recipients, Addressees, Origin, text, Body part) which have to be used to perform the test as well as their relationship.

The content of the « Expected results: » field describes for each element composing the configuration used; their roles, actions and the results about the messages processing during a test performance.

3.5.2.1 Example Gateway Test Specification

Sending a priority two from a Gateway to the remote system

Test n°:	OSC-GW-01-CT-11
Test Type:	Send a message from the Local AFTN site with a DD priority to the Remote AFTN site.
Description:	Origin TTY1: Submit a single AFTN message containing the text of BP01 with a DD priority to the Addressee TTX2 which is mapped onto the Recipient OR02.
Expected results:	IUT (Gateway): a) Receive and convert the AFTN message into a single AMHS message with the Body part BP01H containing the text BP01. b) Transfer the AMHS message to the Auxiliary Gateway. c) Log the situation (Verify the messages logging). Auxiliary Gateway: a) Receive and convert the AMHS message containing the Body part BP01H into an AFTN message to the Addressee TTX2 containing the text BP01 with a DD priority. b) Convey the AFTN message to the addressee TTX2. Addressee TTX2: Receive an AFTN message containing the text of BP01. Verify the priority is set to DD.

3.5.2.2 Example Message Server Test Specification

Outgoing IPM Transfer

Test n°:	OSC-MS-01-CT-31
Test Type:	Send a valid AMHS message from the Local site to a valid AFTN addressee in the Remote site.

Description:	Originator OR11: Submit a single AMHS message containing the Body part BP01H to the IUT ATS message server to send to the Recipient OR01, which is mapped onto the AFTN Addressee TTX1. Set the AFTN Priority in the ATS-message-priority to FF and the transfer message-priority to Normal.
Expected results:	IUT ATS message server a) Receive route and transfer the single AMHS message containing the Body part BP01H to the Recipient OR01. b) Log the situation (Verify the messages logging). AMHS/AFTN Gateway: a) Receive the single AMHS message from the IUT ATS message server. b) Convert the single AMHS message into a single AFTN message and send it to the Addressee TTX1. Addressee TTX1: Receive the single AFTN message. Verify the AFTN priority is set to FF.

3.5.3 Test Summary

A summary of the Test Scenarios is provided in the following sections. Each Test Scenario has been refined into a set of one to four separately specified interoperability tests. Full details of the Test Specification can be found in [A262]. Details of O/R Names and AFTN Addresses Definitions are also provided in this document.

3.5.3.1 Gateway Test Scenarios

Gateway Normal Condition tests	Sending a priority two message from a gateway to the remote system
	Sending a priority three message from a gateway to the remote system
	Sending a priority message one message from a gateway to the remote system
	Receiving a priority two message from a remote system
	Receiving a priority one message from a remote system
	Receiving a long message from a remote system
	Receiving a message with more than 21 recipients from a remote system
	Receiving a large message with more than 21 recipients from a remote system
	Conversion from AMHS IP RN to AFTN Acknowledgement Message
	Conversion from AFTN Acknowledgement Message to AMHS IP RN
	Conversion from AMHS NDR (unrecognised O/R name) to AFTN Unknown Addressee Service Message
	Conversion from AFTN Unknown Addressee Service Message to AMHS NDR (Unrecognised O/R Name)
	Gateway Throughput

Table 4 : Gateway Normal Condition Test Scenarios

Gateway Abnormal Condition Tests	Network Failure and Recovery
	Unavailability of Remote System
	Unsuccessful Conversion of Addressee Indicator in Incoming AFTN Message
	Unsuccessful Conversion of Originator Indicator in Incoming AFTN Message
	Unsuccessful Conversion of Recipient O/R Name in Incoming AMHS Message
	Unsuccessful Conversion of Originator O/R Name in Incoming AMHS Message
	Receiving an Incoming AMHS Message with an invalid Content Type
	Receiving an Incoming AMHS Message with a non-AFTN compatible body part
	Receiving an Incoming AMHS Message with multiple IPM body parts
	Receiving an Incoming AMHS Message with a missing ATS Message Header
	Receiving an Incoming AMHS Message with an invalid ATS Message Header
	Receiving an Incoming AMHS Message containing an invalid character

Table 5 : Gateway Abnormal Condition Test Scenarios

3.5.3.2 Message Server Test Scenarios

Message Server Message Transfer Tests	Outgoing IPM Transfer
	Incoming IPM Transfer
	Outgoing Probe Transfer
	Incoming Probe Transfer
	Outgoing Delivery Report Transfer
	Incoming Delivery Report Transfer
	Message Server Throughput
Message Server Distribution List Tests	Locally Generated Message Sent to Distribution List
	Remotely Generated Message Sent to Distribution List
Message Server Submission Tests	Message submission
	Probe submission
Message Server Delivery Tests	Message Delivery
	Delivery Report Delivery
	Non Delivery Report Delivery
Message Server Message Store Access Tests	Indirect Submission
	Summary of Message Store
	Listing of messages
	Fetching a message
	Deleting a message

Table 6 : Message Server Normal Condition Test Scenarios

Message Server Abnormal Condition Tests	Message non delivery
	Distribution List Loop Detection
	Prohibited Use of Distribution List
	Distribution List containing a recipient which does not exist
	Network Failure and Recovery
	Unavailability of Remote System

Table 7 : Message Server Abnormal Condition Test Scenarios

3.6 Test Schedule

The basis for defining the test schedule is derived directly from the Interoperability Tests described where each test is intended to use one of five possible configurations:

- Two configurations involving the AMHS Gateway to be tested in combination with either an other AMHS Gateway (configuration 1) or an ATS Message Server (configuration 2). This set of tests corresponds to an amount of 25 scenarios. In this case the AMHS Gateway to be tested represents the IUT (Implementation Under Test).

- Three configurations involving the ATS Message Server to be tested, an AMHS Gateway, an ATS Message Store and an ATS Message User Agent. This whole set of tests corresponds to the remaining 25 scenarios. In this case the ATS Message Server to be tested represents the IUT.

The main goals of the test scheduling are:-

1. To classify the tests in sequence to optimise the execution of tests;

2. To reduce the overall test duration;

3. To generate an estimate of each test duration.

3.6.1 Test Suite

To establish the test suite, the following considerations are taken into account and listed hierarchically:

- The Implementation Under Test type (the Gateway or the Message Server),

- the configuration used to perform a test (one configuration among five),

- in a given configuration, the initiator of the communication (the Local site or the Remote site)
- If any, the test(s) directly in relation with a specific test to be "classified" (e.g. Test leading to a Non Delivery Report).

Practically, in reference to the items immediately above, in order to minimise the number of re-configurations and the associated workload too, it has been considered thus some basic principles such as:

- The gathering of the whole of the tests referring to a configuration for a given Implementation Under Test. This avoids the need for unnecessary hardware reconfiguration.
- The gathering, in a given configuration, of the whole of the tests applying to a communication direction.
- And for a given Implementation Under Test, all the tests referring to the configuration of a particular site (local or remote) have to be done in sequence.

3.6.2 Test Duration Estimation

3.6.2.1 Assumptions

The following assumptions may have made for the estimation process:

1. The use of automatic test tools. The characteristics and the benefits of interoperability test tools for the AMHS interoperability testing are discussed in section 3.7. The database comprised in such test tools is of a great help to record in sequence, meeting the test schedule scheme, all the interoperability tests as well as to enable to separate the two different activities being the test "program" and the test "execution".
2. The number of equipment test tools, which have to be involved in the interoperability testing activity. As in each interoperability scenario two sites are at stake and for each scenario a test may be initiated either from the local site or from the remote site; two sets of interoperability test tools are considered to be a minimum and a reasonable number.
3. Despite the use of interoperability test tools, the monitoring of the execution of each test will remain a manual activity. Thus the checking is achieved test after test and in case it happens a test failure, the execution of the test suite can just re-start after this test failure.
4. The execution of each test and the transition process between each test is optimised. For instance a single button click would be an appropriate technique to progress through the test suite enabling continuous monitoring of process.
5. It is assumed that when a test fails the sequence continues with the following one.
6. The two sites involved in a configuration (the local site and the remote site) are geographically remote so that:

- the test execution behaviour remains as close as possible to an operational configuration,
- the margin of error is limited.

3.6.2.2 Margin of error

The margin of error is a consequence of approximations used. This has to be analysed mainly to be aware of the potential consequences and the degree of reliability of the final results. The margin of error may also be influenced by:

- The capacity of the AMHS network support (in term of the throughput of links or trunks).
- Unexpected failures.
- Difficulties to analyse the results as it depends on the type or the “quality” of the Human Machine Interface used to display.
- The test tool configurations.

3.6.2.3 Method & Results

The test suite can be divided into 4 categories of tests:

- Those aiming at exchanging a few number of small sized messages.
- Those aiming at testing the throughput.
- Those aiming at testing the AMHS system behaviour in case of a network failure.
- Those implying the sending of a large number of messages or of a long sized message.

Each test execution process can be broken down into different steps the duration of which can be estimated. The 4 following steps can be distinguished:

1. the interval between the previous and the current test,
2. the manual test triggering off,
3. the different operation processing implied by the crossing of the various AMHS components,
4. the checking and the analyse of the final test results comprising both the verification of messages received and logging files.

The following paragraphs focus on the test duration estimation for each test type.

3.6.2.3.1 Exchange of a few number of small sized messages

This represents the large majority of tests.

- The major impact is due to the last two items of the step list above.

The exchange of this type of messages is different from a file transfer in term of time transfer. It is thus reasonable to fix the duration to process messages from the sender to its recipient(s) to the order of a few minutes (3 minutes).

- The duration value of the final test result checking is set up to 4 minutes for each test (at first sight it is a reasonable assessment to check a logging file and message(s) received).

- The first two steps (interval between tests and test starting) are given a value of the order of a few minutes (2 minutes).

- Ultimately the conclusion raises that a value of 5 minutes dedicated to each test bringing about the processing of several AMHS messages is satisfying according to the set of hypothesis and approximations listed above.

- These items are summarised in the Table below:-

Step	Duration (minute)	Margin of error (minute)
Interval between the previous and the current test.	4	± 2
Manual test triggering off.	1	± 1
Processing of the message between the sender and the recipient(s).	10	± 2
Checking and analyse of the final test result.	15	± 2
Total for a test.	30 ± 7 minutes *	

3.6.2.3.2 Test of the throughput

Each test concerning the throughput lasts 1-hour in order to verify if the IUT is able to handle a given traffic load during a peak hour.

The step intended to verify the results is therefore “longer” than for all other types of tests.

Step	Duration (minute)	Margin of error (minute)
Interval between the previous and the current test.	10	± 2
Manual test triggering off.	1	± 1
Processing of the message between the sender and the recipient(s).	60	± 2
Checking and analyse of the final test result.	20	± 5
Total for a test.	90 ± 10 minutes*	

*Note: The margin of error is lower than for all other categories of tests thanks to the large part of the test dedicated to the automatic message processing which by principle minimises the margin of error.

3.6.2.3.3 Test of network failures

In case of a test failure the 3 following items have a particular consequence on the total test duration:

- The test achievement needs specific hardware or software manipulations (de-connection and connection cables or put network links out of order)
- Before performing the failure, time is needed to transfer messages,
- After the end of the failure, time is needed for the system to recover before examining the results.

Step	Duration (minute)	Margin of error (minute)
Interval between the previous and the current test.	4	± 2
Manual test triggering off.	1	± 1
Transfer of several messages before achieving the failure.	5	± 1
Hardware or software manipulations	30	± 5
System recovery and continuation to	5	± 1

transfer messages after the failure.		
Checking and analyse of the final test result.	15	± 5
Total for a test.	60 ± 15 minutes	

3.6.2.3.4 Tests concerning large sized messages

It corresponds to a few numbers of tests. It mainly deals with tests intended to check if a long sized message sent by an X.400 terminal can be correctly split to be conveyed in the AFTN domain through a gateway.

Step	Duration (minute)	Margin of error (minute)
Interval between the previous and the current test.	4	± 2
Manual test triggering off.	1	± 1
Processing of the messages between the sender and the recipient(s).	30	± 5
Checking and analyse of the final test result.	15	± 4
Total for a test.	50 ± 12 minutes	

3.6.3 Summary

After making allowances for estimation error and the possibility of some test failures, the elapsed duration of testing is estimated to be:-

Number of hours of work per day.	Total nominal value of the test suite duration.	Total maximum value of the test suite duration.
5	10 days and 2 hours	13 days
6	8 days and 4 hour	10 days and 5 hours
7	7 days and 3 hour	9 days and 2 hours

Table 8: Summary of Test Duration Estimation

Full details of the Schedule that was used as the basis for the estimation can be found in [A263].

3.7 Use of Test Tools

This section looks at the benefits which could possibly be gained through the use of tools in AMHS interoperability testing. In the context of this document, “test tools” are taken to mean systems consisting of hardware and software which are implemented, procured and operated for the purpose of supporting the test operators and making the testing process more reliable and efficient. Test tools are normally distinct from the systems being tested and are not normally used outside of the interoperability testing phase of network implementation.

3.7.1 General Benefits of Test Tools

This discussion is restricted to a consideration of possible benefits in a general context and not specifically within the context of AMHS interoperability testing.

The following features could be used to characterise interoperability testing in general.

- the distributed environment in which parties involved in the testing are not located at one site and need to communicate efficiently and accurately and in a fashion which allows the recording of their interactions;
- the need to repeat sets of interoperability tests when new (releases of) protocols have to be tested or when new network configurations make this necessary (“regression testing”);
- test specifications which are subject to continual extension and modification, for example in the case of when, during operations, new difficulties are encountered which should have been identified and excluded in interoperability testing;
- possibly large data volumes (test sequences, test results and their summaries);
- the need to produce concise, consistent and accurate documentation.

Corresponding to these points above, the following benefits might be achieved by the use of tools:

- **communication in the distributed environment**: standardisation and automation of the interactions among operators performing the tests so that dependencies among interactions in the test cases can be reliably executed;
- **repeatability of tests**: provision of means for exact repetition, automatically comparing result with former results;[4]
- **maintenance of test specifications**: performing of version control on test specification databases;
- **administration of data**: storing and manipulation (by means of dedicated database programmes) of test data, including (possibly) the automatic capture of raw test data from the test execution;

[4] Originally AMHS interoperability testing was planned to be a one-time activity. However this is not likely to be true, with tests being repeated over a long period of time.

- **document preparation and maintenance**: automatic creation of reports from the test input and results.

Overall, interoperability testing is a rather "expensive" operation in terms of manpower and elapsed time for co-ordination, test execution and result analysis. However it is essential before taking new systems and protocols into operation. Any reduction in effort made possible by the use of support tools should be seriously considered in order to reduce overall costs.

A further important aspect is the improved overall quality of tests and their documentation to be expected when tools are employed: tools have the effect of formalising the definition and execution of tests.

3.7.2 Possible Benefits for AMHS Interoperability Testing

The general benefits identified in the previous section are now considered specifically in the context of AMHS testing whose objectives and scenarios are defined in [A260] and [A261] respectively.[5]

3.7.2.1 Testing Interfaces

"Testing interface" is used here to mean an interface at which an operator (or possibly a system external to the test configuration) interacts with the IUT or other system in the test configuration. Each test scenario involves interactions at two (or more[6]) interfaces. Such interactions can be classified as "active" (the operator or external system initiates an action at the interface in the IUT or other system) or "passive" (the operator or external system expects to see specific results at the interface).

Active interactions need to be scheduled, e.g. in the case of sending responses confirming message receipt. Passive interactions need to be analysed and correlated with the active interactions and with each other in order to yield the result of the test.

One such active interaction is with the network (OSC-GW-14, Network Failure and Recovery in [262]).

Whereas this number of interfaces involved here is rather restricted and the complexity low,[7] it is nevertheless considered that automated test tools could provide useful benefits in increasing the effectiveness and quality of test execution.

3.7.2.2 Distribution of Systems in the Test Configurations

The scenarios defined are not specific about the location of systems contained in the test configurations. In the case of AMHS interoperability testing however, it is highly likely that the systems involved will be distributed across Europe, i.e. in each configuration (with

[5] [A261] lists in its Section 3.1 the basic equipment necessary for the execution of the test scenarios as specified there. The "test tools" considered in this present document are possible additional, but not essential equipment.

[6] Interfaces for message submission/retrieval and those e.g. for retrieving log information should be considered separate here.

[7] Much more complex configurations could have been envisaged!

the possible exception of configuration 5 - one MS with two UAs) at least one system will be remote from others.

It is considered that, from the viewpoint of efficient and reliable communications, automated test tools could be highly beneficial in the AMHS interoperability testing environment.

3.7.2.3 Test Case Definition and Maintenance

This is an off-line activity[8] by means of which the test case definitions (produced, for example, with word processors and documented on paper) are entered into the test tools and maintained there in a machine-processible form.

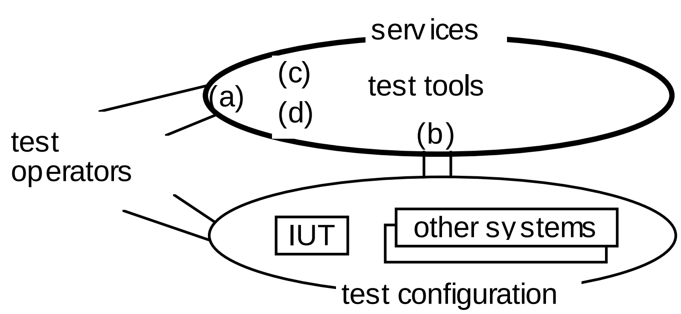
The logic of AMHS interoperability test cases is rather straightforward with few branches etc. It is not expected that support tools for the maintenance of test case definitions and e.g. the automatic generation of messages to be sent and those to be expected would bring about a significant increase in efficiency.

3.7.2.4 Test Documentation to be Produced

[A261] lays out a structure for test reports. This could be usefully derived from test results maintained in a more extensive database in an automatic way.

3.7.3 Possible Services Provided by Test Tools

In this section, the “interoperability test tools” are considered as a black box with no regard to their implementation. The possible services supplied by them at the boundary of the black box are identified and structured into four groups. A possible subset of these, which might usefully be implemented is recommended in the following section. The logical model and the nomenclature used is shown in Figure 8



For (a) - (d) see following text

Figure 8: Logical model and nomenclature.

3.7.3.1 Test Operator Interface

This set of services involves the interface of the test tools with the test operators. On this interface three sets of services could be provided. See (a) in Figure 8.

[8] by comparison, for example, with the test execution, which would be “on-line”.

3.7.3.1.1 interact with database

A major part of the test tool functions could be a database containing test cases, results, configuration data etc. - see section 3.7.3.4. On an appropriate interface these functions could be made available to test operators.

3.7.3.1.2 control test execution

By means of an appropriate interface, the test operators could have the possibility of controlling test execution on the test configuration, either automatically or manually with support functions provided by the test tools - see section 3.7.3.3. This would involve, for example, the proper sequencing of interactions derived from the test cases.

3.7.3.1.3 communicate with remote operators

Since the test configuration and its operators are, in general, distributed across more than one location, there is a need for the operators to communicate with each other. This service could be provided by the test tools.

This communication function is central to the testing process and needs to be discussed in the context of test tools: interactions among test operators need to be recorded and coupled with actions performed at the test locations.

3.7.3.2 Interface to IUT and other Systems

It could be possible for the test tools to have direct, machine interfaces to the test configuration as shown in **Error! Reference source not found.**. These interfaces could be for message submission and retrieval, inspection of log information, etc. Three types of services could be provided by the test tools. See (b) in Figure 8.

3.7.3.2.1 interface for active control of IUT or other system

On this interface, the test tools could directly and actively control the test configuration according to the test cases, e.g. by submitting and retrieving messages.

3.7.3.2.2 interface for retrieving information from IUT or other system

As part of the test execution, the test tools could retrieve information such as logs which is stored in the test configuration via this interface.

3.7.3.2.3 cause changes in network

A machine interface to the network could be used for the testing of failure modes, which can be controlled by software.

3.7.3.3 Test Execution

The carrying out of the tests could be supported in three different ways. See (c) Figure 8.

3.7.3.3.1 generate test data from test cases

Test data such as messages and their contents and expected results could be generated from the test scripts and made available to test operators or used directly via the interface described in section 3.7.3.2.

3.7.3.3.2 execute logic of the test cases

The dependencies inherent in the test case logic could be made available to test operators or used directly via the interface described in section 3.7.3.2. A scheduling function could also be considered here.

3.7.3.3.3 record results

Logs of test case execution could be recorded in the test tools.

3.7.3.4 Database Maintenance

The database contains data on which the tests are based and data resulting from the tests. See (d) in Figure 8.

3.7.3.5 test case maintenance

Part of the database could be the test scripts themselves in various versions together with their update history. Provision could be made for the comfortable editing of test scripts.

3.7.3.6 results data maintenance

Part of the database could be the sets of results obtained in executing tests correlated with the test scripts and test configurations themselves.

3.7.3.7 report generation

Test reports as specified in [A260] could be generated automatically or partially from test results maintained according to the service described in section 3.7.3.6.

3.7.4 Strategies for Test Tool Procurement

On the basis of the discussions in previous sections, possible strategies for the implementation of test tools are analysed in this section and recommendations are made.

3.7.4.1 General principles

3.7.4.1.1 Justifiable Development Effort

In order to estimate the effort, which could sensibly be spent on the development and deployment of AMHS interoperability test tools, it is necessary to have a feel for the frequency and intensity of use which such tools may expect.

AMHS interoperability testing within the ACCESS Project was originally intended to be a one-time activity. With the actual test execution now postponed to take place outside the project, the estimates of effort still remain valid. However the possible repetition of tests becomes more likely.

Document [A261] contains[9] estimates of the effort necessary for developing test scripts and configuration files amounting to 22 man-days per IUT. The existence of test tools is

[9] Section 3.2

likely to have little impact on these activities[10] so that it is necessary to look at the effort involved in actually performing the tests.

It is estimated that, for each IUT, each of the 25 test cases would require approximately one half of one day for its execution plus an overhead of 5 days for setting up, report preparation etc. During these 17.5 days, the presence of 2 people can be assumed, one at each of two locations. This yields an order-of-magnitude estimate of 35 man-days for the testing of each IUT. This estimate does, of course, not take into account repetitions, which become necessary when tests are not successfully completed.[11]

Assuming that 6 different IUTs would have to be tested during the introductory stages of the AMHS, an total effort in the vicinity of 200 man-days appears realistic.

For the purpose of discussion,[12] a basic reduction in effort of, say, 30% which is due to the use of appropriate test tools can be assumed. This analysis leads to the conclusion that, simply from a cost/benefit point of view, an effort of 70 man-days for the development and procurement of test tools could be justified.[13]

The figure of 30% for the reduction in effort through test tools is, as for the other figures used here, important for the conclusions drawn in the following sections. It is based on the authors' experience for a medium-scale testing activity.[14]

3.7.4.1.2 Basic Approach

The allowable effort derived in the previous section is not large, by any means, in the context of systems development. It follows that, simply form a cost point of view, the approach for organising the use of test tools needs to be pragmatic.

One necessary conclusion is that the development, procurement and provisioning of the tools should be in the hands of one of the test participants rather than being contracted out to an organisation which is responsible for providing test support.[15] This is necessary in order to reduce and simplify the human interfaces between users and suppliers of the test tool support in connection with specification, modification, training etc. It is reasonable to assume that this designated test participant would also be willing to provide the support even when the organisation is not the owner of the IUT or of other systems involved.

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[10] It is assumed that some machine support would be used in these activities anyway.

[11] As a side-effect, the existence of test tools would encourage the execution of interoperability testing.

[12] This discussion does not take into account that test tools can, in addition, increase the quality of testing.

[13] Part of this effort would possibly have to be assigned to the purchase of hard- and software. However this is likely to be small in comparison with the manpower effort.

[14] The more extensive and repetitive the testing activity, the higher this figure becomes.

[15] Of course, this does not restrict the possibilities of the test participant to contract work out.

The small amount of effort justifiable for implementation also requires that a simple approach to the technical development, procurement and deployment, using as many standard components as possible, is necessary. This is in view of the fact that the tools to be implemented would only be applicable to the concrete task at hand, i.e. to AMHS interoperability testing, and not to a wider context.

3.7.4.2 Recommended Test Tool Services

In the light of the discussion in the previous sections, recommendations are made in Table 9 whether services identified in section 3.7.3 should be implemented or not. Note that implementation matters are not yet being considered here.

reference	service description	implement? (yes/no)	reasons
3.7.3.1.1	interact with database	yes	essential service, simple to implement with standard software
3.7.3.1.2	control test execution	yes (restricted)	only instructions are given to test operator: no direct control
3.7.3.1.3	communicate with remote operators	yes	important because efficiency and quality can be improved significantly
3.7.3.2.1	interface for active control of IUT or other system	no	expensive to implement and dependent on type of IUT i.e. a general implementation is not possible.
3.7.3.2.2	interface for retrieving information from IUT or other system	no	expensive to implement and dependent on type of IUT i.e. a general implementation is not possible.
3.7.3.2.3	cause changes in network	no	necessary in only few test cases and therefore not justifiable
3.7.3.3.1	generate test data from test cases	yes	can be of great assistance to test operator
3.7.3.3.2	execute logic of the test cases	no	not possible if IUT and network interfaces not available
3.7.3.3.3	record results	yes (restricted)	done manually by test operator; not possible automatically if IUT and network interfaces are not available.
3.7.3.5	test case maintenance	yes	important core service
3.7.3.6	results data maintenance	yes	important core service
3.7.3.7	report generation	yes	database function, easily implemented

Table 9 : Recommended Test Tool Services

One result which follows from the recommendations made in the above table is that fully automatic testing will not be supported by the test tools. This would have necessitated, in addition to the other services, all of the services in the table for which a “no” has been given in the "implement?" decision. Expressed differently, the test tool strategy requires that test operators remain in the "test loop" during testing.

3.7.4.3 Centralised versus Decentralised Tool Configuration

One important conclusion from the analysis in the previous section is that no machine interfaces between the test tools and the IUT or other systems (as shown by (b) in Figure 8) should be implemented. The test operators always remain in the "test loop" and make use of the support provided by the test tool. This opens the possibility of implementing the test tools at one central location with remote access from the participating locations.[16] A comparison between a centralised and decentralised test tool configuration is shown in Figure 9.

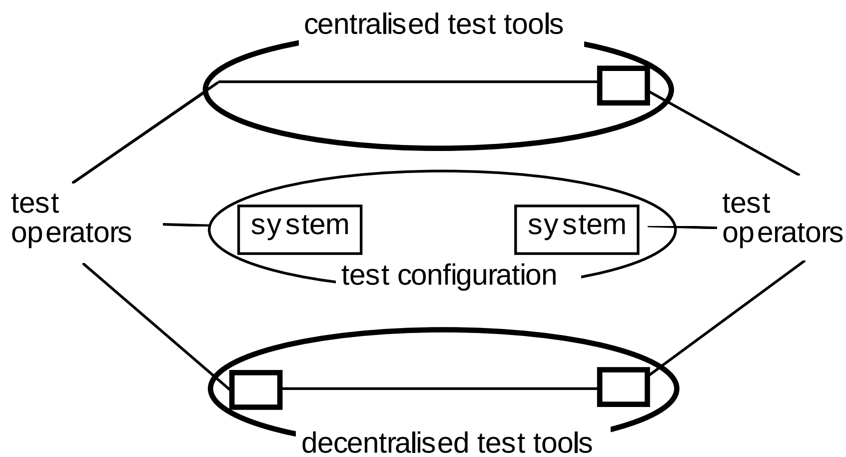

Figure 9: Comparison between centralised and decentralised configurations

In terms of simplicity, the centralised approach clearly has a number of advantages without causing increased communication costs. It is therefore recommended that the test tools be implemented centrally in one computer system allowing access from local and remote test operators.

For the networking between test operators and the centralised tool system a number of options are possible:

- ATSO packet switched WANs,
- the same communication infrastructure as is used by the systems in the test configuration,
- the Internet, e.g. by means of the Telnet protocol (security problems are not considered to be important here).

Availability and ease of use should be the criteria used to make a choice among these options.

Assuming the adoption of the centralised approach to the implementation of test tools, the portability of the tools would not bring any significant advantages. However because of

[16] Of course machine interfaces to IUTs and other systems would also be possible from a central location but this is considered to introduce too much complexity and would not be justifiable.

the small scale of the implementation (see the following sections), the tools can be considered to be portable in any case.

3.7.4.4 Functional Requirements

This section lists some high-level functional requirements placed on the test tool. According to the recommendations derived in preceding sections the tool consists of a central server which is accessed from terminals over a data network. Only requirements placed on the server (and not the terminals) are discussed here and the following sections. They are derived from section 3.7.3 and the results of section 3.7.4.2.

The core of the tool functionality is a database application. This is responsible for administering the three sets of data listed in section 3.7.3.4, together with data on the test configuration. For the implementation, industry standard database systems should be considered. In addition, transient sets of data such as messages to be sent, instructions to the test operator will exist during the preparation and execution of tests.

Support software shall exist for the creation and maintenance of test scripts in different versions, including plausibility checks.

On request of the operator, the steps to be carried out by him and expected events shall be derived by the test tool from test scripts and configuration data. The operator shall be able to enter the current state of a test and receive an updated step sequence.

For each test executed, acknowledged test steps, with optional comments from the operator shall become part of a test log (results database).

Reports on test execution shall be generated on the request of the operator in a format which can be flexibly adapted to future needs.

The possibility of communication with remotely located test operators shall be integrated into other functions, e.g. transferring the current test status. In addition there shall be the possibility of communication free text messages via the test tool. There is only a need for communication within Europe to be foreseen.

This functionality shall be made available at a test operator terminal interface which is connected to the server by a data network. Administrative functions shall control the access of operators to the tool by means of passwords.

3.7.4.5 Non-functional Requirements

The performance requirements placed on the test tool are minimal.

The number of terminals/workstations accessing the server application at any one time shall be restricted to one per test location and the total number of transactions per second is likely to be far less than one per second on average. The data volumes involved are likely to amount to only a few megabytes.

As a result of this, no dedicated hardware is necessary and the creation of a new (set of) application(s) on existing or shared hardware will suffice. Availability requirements are relatively high so that tests are not interrupted by the failure of the tool. However the availability normally provided by non backed-up servers will suffice.

A functional and quantitative extensibility of the system shall be implemented.

Note: A consideration of these requirements and those of the previous section leads to the conclusion that the test tools can probably be implemented on commercially available PCs with sufficient memory, processor speed, communication ports, standard software etc. It appears unlikely that the resources of bigger systems such as workstations, for example, would be needed.

4. CONFORMANCE

4.1 Introduction

The principle purposes of this section are:

- to provide enough background information on the AFTN/AMHS Gateway specification in order to show the need and critical areas for its conformance testing,
- as a result of these requirements, elaborate a number of options for performing the conformance testing,
- to make a number of recommendations concerning the options available.

Having demonstrated the need for the conformance testing of the AFTN/AMHS Gateway, the document aims to present the strategy recommended by the ACCESS Consortium.

4.2 Conformance versus Interoperability Testing

In Section 2 of this document the distinction is made between interoperability testing, conformance testing and reference testing. Conformance testing is defined as the exhaustive testing of a system under test against the functions and procedures defined in an agreed standard. A rigorous approach would test all the ‘shall’ and ‘should’ statements in the design specification.

It is clear that the type of testing performed during conformance testing is basically different from that of interoperability testing. In particular, in conformance testing

- some test sequences can be performed which would not be possible within the scope of interoperability testing, thus exercising the full scope of the specification,
- whereas performance and load testing are possible, at least in principle in interoperability testing, this is not usually considered in conformance testing which is restricted to the ”logic” of the protocol implementation,
- individual layers, components and interfaces of the SUT might be considered individually whereas this is never the case in interoperability testing.

It is argued in the following section that these test activities are not appropriate for the components of the AMHS in general but indeed for the AFTN/AMHS Gateway.

4.3 The Need to Perform Gateway Conformance Testing

Interoperability testing is appropriate for the testing of the AMHS components

ATS Message User Agent and

ATS Message Server

for the following reasons.

- Implementations of functions in these components are based on widely used, stable and mature specifications.
- It can be assumed that such implementations contain, as their major parts, standard protocol software packages, which are already in operation in a number of different environments. Type approval resulting from formal conformance testing would normally exist as a precondition for the marketing of such packages.
- For the implementation of these two types of AMHS components, standard packages merely have to be tailored to the specific AMHS environment according to standard profiles, as specified in [ICAO1]. The tailoring of standard packages does not invalidate type approval.

However these arguments do not necessarily apply to the AFTN/AMHS Gateway for the following reasons.

The Gateway has been specified for the first time in [ICAO1] and represents a new set of functions.

The functions specified in [ICAO1] are being implemented by various manufacturers for the first time.

No well-tried, established procedures exist yet for conformance testing and type approval of implementations of the AFTN/ATN Gateway.

Because of the fact that the specification in ICAO1] has not yet been implemented in full and validated in the field in real networks, it is likely that conformance testing might have some backwards effect on the specification. In similar cases it has been found in the past that whereas protocols have been implemented exactly according to the specification, this was not always what those writing the specification had in mind. Such discrepancies may come to light because the conformance test equipment would normally interpret the specification in the way it was originally intended.

Similarly it is inevitable that ”grey areas” in the specification only show up when implementations are taken into operation and this can lead to considerable wasted effort in network implementation and operation. If such grey areas had been identified and eliminated during conformance testing and before implementations were taken into operation, considerable effort could have been saved. For this reason, conformance test suites are usually subject for continued expansion as such areas are discovered.

In general, it can be stated that the conformance testing activity is very inexpensive in terms of effort when compared with interoperability testing and gives great benefits. This is due to the simplified logistics (testing in one, e.g. a laboratory location, instead of being distributed over several locations) and the use of dedicated equipment and well-defined test scenarios.

Since the late 1980’s, conformance testing has gone somewhat ”out of fashion” in the communication community. It was advanced in the 1980’ because of the completion of OSI network and application protocol suites and the recognition of the need for appropriate testing infrastructures. As a result, much effort was put into the definition of conformance testing strategies and test suites and into the setting up of conformance testing laboratories and the formalism for the issuing of type approval certificates. The effort and cost of these activities were generally underestimated. Together with the reluctance of manufactures to subject their products to conformance testing, this has led to a reduction in the amount of conformance testing currently taking place.

However the arguments made above in favour of performing conformance testing on new implementations of the AFTN/AMHS Gateway remain valid and the ACCESS Consortium recommends that this be done.

4.4 AFTN/AMHS Gateway

This section gives a very brief, informal description of important features of the AFTN/AMHS Gateway derived from the definition contained in [ICAO1] from the point of view of conformance testing. This is intended to provide background for the ensuing discussion.

The SARPs contain the following statement of the purpose of the Gateway:

An AFTN/AMHS Gateway shall provide for an interworking between the AFTN and the ATN such that communication with other AFTN/AMHS Gateways and with ATS Message Servers is possible.

The Gateway is therefore seen to be a network element providing interworking between two different environments without any further end system (or end user) functions. Conformance testing of the Gateway must ensure that this interworking function is implemented correctly.

"Interworking" in this context implies that the network environment "hidden behind" the Gateway must appear to be compatible with the environment from which it is considered. This means that the AMHS infrastructure on the ATN, when seen via the Gateway from the AFTN, must appear to be part of the AFTN. Conversely, the AFTN, when seen via the Gateway from the ATN, must appear to be part of the AMHS. These characteristics are illustrated schematically in Figure 10.

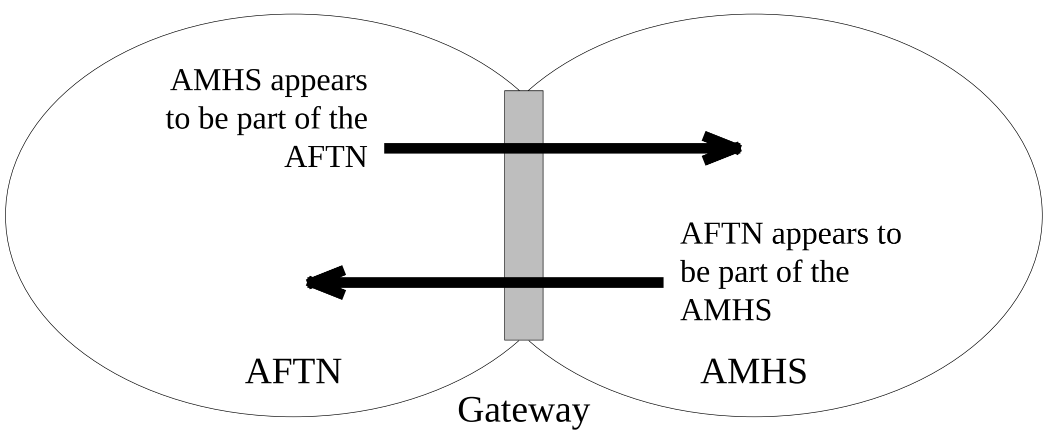

Figure 10: Representation of the Gateway functions from the two networks

More specifically: The Gateway is seen from the AFTN to be an AFTN Station connected to one AFTN switch. All AMHS users, reachable by the Gateway, are represented by AFTN users at this Station. Conversely, the Gateway is seen from the AMHS to be an ATN End System, an ATS Message Server, which is an Access Unit (AU) supported by a Message Transfer Agent (MTA). These two different views of the Gateway could also be from another AFTN/AMHS Gateway. Major general functions, which are performed in the Gateway are address and message conversion together with traffic logging.

The view of the Gateway from the AFTN implies that the Gateway, with its own AFTN address, must satisfy the requirements of an AFTN Station according to Annex 10. This includes, for example, the requirements on recording and on the handling of service messages.

The view of the Gateway from the AMHS implies that the Gateway must satisfy the requirements of ATS Message Servers according to the standards and profiles used for their definition.

In addition, the Gateway must perform conversion functions and provide a control position which, however, are not "'visible" in these two views of it. This decomposition has lead to a logical structuring of the Gateway into four components as shown in Figure 11.

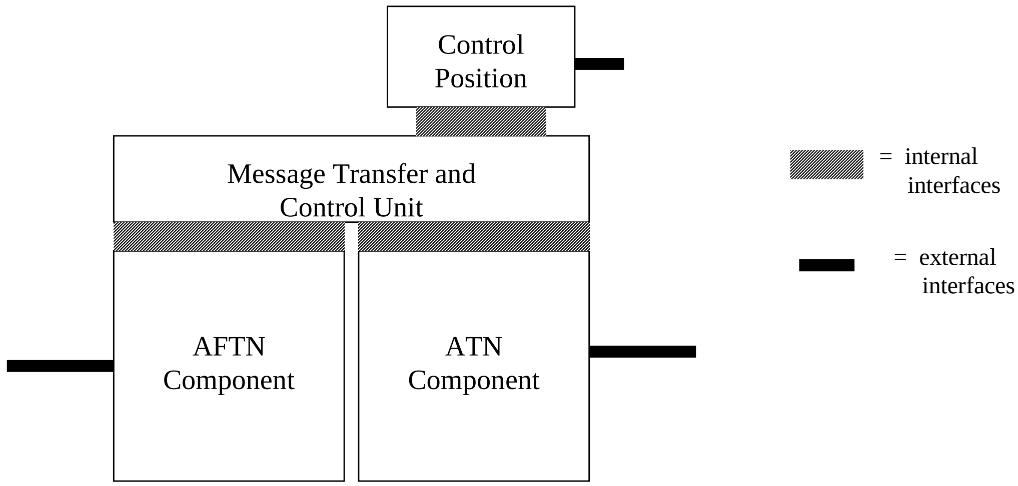

Figure 11: Logical structuring of the Gateway

The SARPs point out clearly that, although this is a convenient way to partition the Gateway for purposes of defining its functions, there is no requirement for the Gateway to actually be implemented in this fashion. This is important from the point of view of conformance testing because it means that there is no possibility of accessing the internal interfaces shown in Figure 11 but only via the three external interfaces shown.

The structuring of the Gateway in this fashion does, however, imply that the AFTN Component cannot simply be software identical to that in an AFTN switch. For example, only those messages received from the AFTN which could, in principle, be handled by the Message Transfer and Control Unit are actually passed on to it. Similarly, the Control Position is not specified in detail in the SARPs. It could, for example, be an intelligent system component implemented mainly in software or simply an interface to a human operator.

4.4.1 AFTN/AMHS Gateway SARPs

This section contains a brief overview of the AFTN/AMHS Gateway SARPs for the purpose of analysing the requirements to be placed on conformance testing suites.

The specification of the Gateway is contained within the ATSMHS SARPs which is part of ATN SARPs in Sub-Volume 3 (Ground-Ground Applications). Version 2.2 (January 1998) is assumed here, [ICAO1].

The SARPs distinguish between the "AFTN/AMHS Gateway" and a "Type A Gateway" providing a pass-through service without further recourse to messaging handling protocols. In keeping with the ACCESS strategy - see [A260], the Type A Gateway is not considered here.

The AMHS SARPs rely heavily on existing international standard protocols and on their international standard profiles. For this reason, the specification of the ATS Message Server - with the exception of the Gateway - amounts to only a very small volume of provisions (only a few pages). Additional functions, which cannot be derived from the international standards are concerned with the IPM Message structure and with AMHS addressing.

More than 90% of the physical volume of the AMHS SARPs (Section 3.1.2) on more than 100 pages relate to the Gateway itself (Section 3.1.2.3). These are referred to here as the "Gateway SARPs".

It is important to note that the functions defined here are new and have not yet been subject to widespread implementation, let alone tested back to back across the ATN. This is certainly justification enough for proposing that implementations of the Gateway be conformance tested before they are introduced into real networks. A further justification for this proposal is the presence of functions such as priority handling which would be difficult, if not impossible to test successfully within the scope of interoperability testing.

Within the Gateway SARPs, those parts relating to the AFTN Component and to the ATN Component - see Section 4.4 - are also rather "thin" due to the fact that their functionality is defined elsewhere. This fact, amongst others, well justifies the strategy followed in the SARPs of logically structuring the Gateway in this fashion. The definition of remaining functions is concerned with general functions and with the way in which the components use the internal interfaces - see Figure 11.

It follows that the majority of the Gateway SARPs is dedicated to the Message Transfer and Control Unit, amounting to more than 90 of the 100 pages referred to above. They contain provisions for the processing of messages when being transferred between the AFTN and the AMHS components, mainly address and message conversion.

In particular, for the direction AFTN to AMHS (Section 3.1.2.3.4, 34 pages), conversions are defined for messages, service messages and acknowledgement messages.

Similarly, in the direction AMHS to AFTN (3.1.2.3.5, 58 pages), conversions are defined for IPMs, receipt notifications, non-delivery reports and probes.

These provisions for conversion in the Message Transfer and Control Unit can be tested effectively only within the scope of conformance testing (by comparison with interoperability testing). This is due to the large number of cases to test and on the dependencies among the processing of message parameters. In principle, it should be the goal of conformance testing to investigate the implementation of each provision (effectively a "shall statement" in all its details). .

4.5 Conformance Testing Strategy Options

In this section, options open for use in the context of AFTN/AMHS conformance testing are surveyed in preparation for formulating recommendations in the following section.

4.5.1 Conformance Testing in other Contexts

An extensive "tradition" of conformance testing communication system implementations exists and should be taken account of for possible AFTN/AMHS conformance testing. Two types are reviewed briefly in this section.

4.5.1.1 Open Systems Interconnection

The subject matter of conformance testing was formalised and put into extensive practice in the context of ISO and ITU-T Open Systems Interconnection, OSI. This work gained momentum in the 1980s when a large number of standards matured and became stable. Extensive conformance testing methodologies and test suites for implementations of individual standards were defined, even a special language for the specification of test suites, Tree and Table Control Notation, TTCN.

The activity was also supported because many publicly funded projects came into being and it was felt that this was a typical task for public institutions such as the European Commission and that the setting up of infrastructure and procedures could not be expected from purely privately financed organisations. One of the goals within Europe was the possibility of issuing conformance certifications in one country, which would be recognised in others.

Now, a decade later, it is apparent that, for a number of reasons, a lot of the momentum has left the conformance testing activity, for example,

- At the start, the effort necessary to define and perform conformance testing was highly underestimated. The costs involved in such a one-time activity can be difficult to justify when the decision-makers are not familiar with the cost savings, which can result from effective conformance testing.
- Considerable resistance has come from manufacturers and suppliers of telecommunication equipment to submit their equipment to official conformance testing procedures. On the one hand, this would involve additional effort, which did not immediately give a return on investment and on the other placed constraints on the implementations which made them more expensive.
- The amount of administrative overhead involved in performing tests and issuing certificates has proven to be unreasonable in many cases.

However within well-defined contexts, conformance testing remains an important activity. In particular, the OSILab and its accredited national testing laboratories, utilising results from a number of Commission projects remain active. The former PTT monopolies also maintain test laboratories which issue "type approval" certificates for equipment which is to be connected to "public" networks.

4.5.1.2 CIDIN

In a more specific environment and one which is closer to the ACCESS context, the experiences gained in the implementation of CIDIN are relevant here. To a certain extent, the introduction of new implementations of the CIDIN protocols in CIDIN Centres and Stations show similarities with the implementation of the relevant SARPs in AFTN/AMHS Gateways:

- The specifications are new and there is, as yet, no widespread basis of implementations.
- It is likely that future implementations will come from a number of different manufacturers.
- It is vitally important to demonstrate correctness and stability of the implementations before they are introduced into (existing) networks.

The European States taking part in the CIDIN Trials at the end of the 1980s decided to invest effort into the definition and execution of a conformance testing programme for all new implementations of the CIDIN protocols before taking part in the trials. Some of the generally agreed consequences resulting from this activity are:

- The implementation of CIDIN was thus significantly accelerated, its quality improved and costs reduced.
- The conformance testing activity highlighted "grey areas" in the specifications in a timely fashion.
- When difficulties due to protocol implementation arise in the operational network, the conformance test suites are extended accordingly, providing additional documentation of the interpretation of the CIDIN SARPs, and effectively ruling out the possibility that the same areas will cause network problems in the future.

The testing effort was supported by the existence of a de facto standard set of test equipment dedicated to the conformance testing of CIDIN protocol implementations.

4.5.1.3 Testing of Functional Components

In the context of conformance testing of protocol implementations, it is important to distinguish between the testing of complete systems ("black boxes") and the testing of individual protocol layers (in the sense of a layered protocol architecture), although the former can be seen as a special case of the latter. The distinction is illustrated in Figure 12.

In case (a) of Figure 12, only external interfaces which are part of the product are used for access by the conformance testing equipment. In case (b), on the other hand, the product has to be "opened up", providing access to individual layers. Depending on the methodology employed, a special software module, known as a "test responder", which is defined in the test suites, needs to be located on the interface to the layer under test. This will allow the simulation of the layers above the one under test and allow it to respond with prescribed protocol primitives and service data units. The test harness also needs an interface to the test responder in order to control it.

The situation shown in Figure 12 is relatively simple and the configuration for performing the conformance testing can, in fact, become quite complex. Apart from the definition of the test responder, an additional channel, using the same protocols as those in the SUT can be used for communications between the test equipment and the SUT. The test responder then becomes a "ferry" for conveying events at the service interface of the layer under test to and from the test equipment.

The conformance testing of CIDIN was performed on a layer-by-layer basis but without the use of a test responder.

These options need to be considered for the future conformance testing of the AFTN/ATN Gateway. In addition, the possible need to make the division of an AFTN/ATN Gateway SUT into its three main components - see Figure 11 - also needs to be considered.

An extensive conformance testing programme is currently being planned for implementations of ATN Intermediate and End Systems.

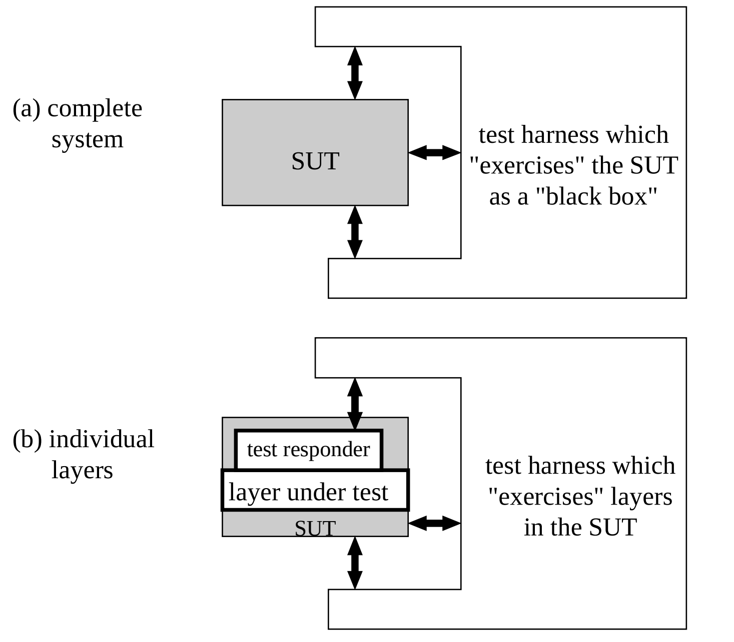

Figure 12: Schematic distinction between the conformance testing of complete systems and individual protocol layers.

4.5.2 Organisational Options

The organisational options open for performing the conformance testing of AFTN/ATN Gateway implementations range from formalised to informal, for example:

- setting up of a formal conformance testing body, possibly under institutional control,
- an industry-led organisation providing a de facto conformance standard
- informal agreement among all participants involved in the implementation of Gateway on their conformance testing and co-operation on setting up the infrastructure and methods for performing it,
- no formal or informal agreements on conformance testing but the possibility of using the results produced, for example, by the ACCESS study.

These considerations raise questions such as the "ownership" of test methodologies and scenarios and the authority of any body performing the testing.

4.5.3 Equipment Options

Efficient conformance testing effectively assumes as a prerequisite the availability of dedicated, special purpose equipment tailored to the specific testing needs. In particular, the provision of the interfaces to the AFTN/ATN Gateway, the maintenance of the test suites in a database in the same form as specified and the presence of (certified!) implementations of ATN/ATN Gateway software components are specific requirements. More generic requirements are the threefold separation of testing activities (setting up and test suite maintenance, test execution, test results evaluation), possibility for performing regression testing on new implementation releases and the generation of test reports.

However a number of options exist in this respect:

To what extent should the test equipment be specified and who should do this?

Should test equipment be procured by one central party (because of the rather small scale of the testing involved) or should this be left open?

Should the implementation of test equipment be left to one manufacturer or should it be procured on the open market?

Recommendations on these and other questions are made in the following section.

4.6 Recommended Approach

As a result of the discussion in the previous sections, recommendations on the approach to AFTN/ATN Gateway conformance testing are made in this section.

4.6.1 Overall Strategy

4.6.1.1 Organisational Arrangements

The conformance testing of AFTN/ATN Gateway implementations is a highly technical but rather small scale exercise due to the likely small number of implementations to be tested. For this reason, a pragmatic organisational approach needs to be taken. It is **recommended** that:

- the conformance testing methodology and the test suites as defined within the ACCESS Project be taken as the basis and possibly extended within the scope of projects involving all major European participants in this area; the agencies such as the European Commission which are the clients in such projects are effectively the owners of the project results;
- a mechanism be set up within the scope of projects referred to in the first point for extending the conformance test methodology and test suites based on experience with trial and operational networks;
- each participant, e.g. ATSO, is responsible for performing conformance testing on the Gateway implementations procured by him with a view to being introduced into the AMHS, and without involving further institutional arrangements; informal statements that conformance testing has been performed according to agreed procedures are necessary before Gateway implementations can be introduced into a trial or operational AMHS;
- as far as possible, participants aim to use common equipment and to share experiences which is documented within the scope of common projects (referred to in the first point).

4.6.1.2 Transparency of Components of the SUT

A number of options have been identified for the "transparency" of the Gateway SUT from the point of view of its conformance testing. On the basis of experience gained in comparable test environments, it is **recommended** that:

- the individual components of the Gateway (AFTN Component, ATN Component, Message Transfer and Control Unit) not be visible to the conformance testing equipment;
- (as a consequence of the first point) the individual protocol layers are also not visible;
- access to the Gateway SUT by the test equipment is only via standard AFTN and ATN network interfaces; the Control Position is not accessed by the test equipment on-line and is assumed to be a human readable terminal interface; during test runs, it has to be

operated (in parallel with the test equipment) for configuring the Gateway extracting error messages, etc.

4.6.1.3 Availability of Test Equipment

Experience has shown that as much commonality in the test equipment used for different test runs should be aimed for. For this reason, it is **recommended** that:

a pragmatic approach to defining test equipment be taken so that such equipment can be procured multiply for the different test sites, emphasising small size and low cost;

the requirements specification for conformance testing equipment in this section be taken as a common basis by all participants and developed further within the scope of further common projects;

for procurement of test equipment participants take as far as possible a common, agreed approach with respect to potential suppliers,

4.6.2 Tasks

This ACCESS WP is the first document discussing a possible future conformance testing of AFTN/ATN Gateway implementations. This section contains a short list of tasks which remain to be performed, most of them within the scope of projects common to all participants.

4.6.2.1 Refine Methodology

Some aspects of the recommended methodology are contained in this document and are further refined in [A271].

4.6.2.2 Specify Test Suites

A first draft of test suites (test case specifications) have been derived from the relevant SARPs and can be found in [A271].

It is expected that the emphasis will be placed on conformance testing of the Message Transfer and Control Component of the Gateway since this is the major new part of a Gateway implementation. Conformance testing of the AFTN Component may also constitute a significant part of the activity since, although AFTN implementations have existed for many years, they have never been subject to general conformance testing. The ATN component can be expected to be a standard implementation and possibly have its own, existing type approval.

4.6.2.3 Create Requirements Specification for Test Equipment

According to organisational recommendations above, participants should aim at using common test equipment. This assumes the existence of a common requirements specification. A first high-level draft is contained in the following section. This needs to be refined by participants in ensuing common projects.

4.6.2.4 Procure Test Equipment

Using the common requirements specification, participants should procure, either individually or in co-operation, implementations of test equipment for ensuing conformance testing.

4.6.2.5 Perform Conformance Tests

According to the overall approach, conformance testing is performed by each participant individually.

4.6.3 Requirements on Test Equipment

As part of a common specification, this section provides a draft, high-level structuring of requirements which are to be placed on equipment for supporting Gateway conformance testing.

4.6.3.1 Functions

The software shall be designed such that the following three phases can be executed repeatedly and independently from one another:

1) off-line phase consisting of test preparation and maintenance of test suites;
2) on-line phase connected to the SUT in which tests are executed
3) post-test phase in which test results are analysed and reports generated.

The functions available shall be appropriate to each of these phases taking into account the test suites specified which emphasise the testing of the Message Transfer and Control Unit component of the Gateway.

A common database system shall provide support to the functions. Multiple versions of database contents shall be maintained for different sets of test suites, test configurations and test results.

It shall be possible to repeat tests using the same configurations for regression testing.

4.6.3.2 Interfaces

The test equipment shall provide the following physical interfaces:

- one interface to the ATN Component simulating at least an X.25 subnetwork and all higher level protocols of an ATN End System required by [ICAO1],
- one interface to the AFTN Component simulating an asynchronous AFTN circuit according to the provisions of Annex 10,
- one operator terminal interface.

The possibility of transmitting contents of the database to other similar sets of test equipment may be provided as an option.

4.6.3.3 System Platform

The system platform used for implementing the test equipment shall be appropriate to the needs of conformance testing of a communications gateway.

The system platform shall be small in the sense that no other functions other than the Gateway conformance testing need to be performed at the same time.

Single-terminal operation shall be provided

There shall be no need to connect the system to other systems via networks in order to perform the functions specified here.

The system shall be portable and stand-alone.

As much as possible of the software supplied shall conform to industry standards.

4.7 Conformance Tests

The conformance tests were identified from the SARPS using the following procedure:

- Identifying all requirements (i.e. identifying all uses of the words ‘shall’ and ‘should’);
- Eliminating all ‘shall’ and ‘should’ statements which are ‘configuration’ statements;
- Eliminating all ‘shall’ and ‘should’ statements which should be tested during formal ISP or AFTN conformance testing which do not contain an AFTN/AMHS IUT component;
- Eliminating all statements which apply to internal interfaces within the IUT - these are implicitly un-testable;
- Eliminating all other statements that cannot be tested by formal conformance testing.
- Tests for the remaining requirements have been combined where reasonably possible to reduce the number of tests. They have then been related to the following sets of tests, each initiated by generation of either an AMHS or an AFTN PDU.

The format of each test specifies:

- The selection of reference PDU elements to be used to initiate the test and specification of modifications or changes to specific field values to the reference PDU required to perform the test;
- The sequence of events required for a valid outcome - i.e. where the IUT is judged to conform to the tested requirement;
- Specification of AMHS and AFTN PDUs which should be generated as a result of the test (by reference to those specified in the annexes to this document);
- Specification of the resultant log contents;
- Specification of any errors which should appear at the IUT’s control position.

Full details of the test specification can be found in [A271].

4.7.1 Test Specification List

The ATSMHS/AFTN IUT test specifications cover the following areas:

1) Control Position Tests

2) AFTN Service message and channel check PDU suppression

3) AFTN to AMHS message conversions

4) Invalid AFTN messages

5) AFTN message acknowledgement conversion

6) AFTN unknown address service message conversions

7) Conversion of AMHS IPM message to AFTN

8) Reject AMHS PDUs

9) AMHS receipt notification conversion

10) AMHS non-delivery report conversion

11) AMHS probe handling

4.7.2 Test Specification Examples

Each test is identified by a reference with the following format CT-GW-XX

- CT - Conformance Test
- GW - IUT
- XX - Test number.

The tests are run under the conformance test scenarios described in [A270].

4.7.2.1 Example of Control Position Test

Error Reporting to the control position

	Error Reporting is considered to be tested in later sections as an outcome of other tests. **IPM UA Requirements of the IUT:** The Control Position part of the IUT should undergo tests for ISP conformance (i.e. to be able to originate IPMs). The Control Position should also be tested for the generation of RNs and NRNs.

4.7.2.2 Example of AFTN Service Message and Channel Check PDU Suppression

AFTN Service Message and Channel Check Suppression

CT-GW- 1	
Description:	The tester generates a stream of AFTN channel check PDUs and a selection of all other types of AFTN service messages except end-to-end acknowledgement service messages and end-to-end unknown addressee service messages in the absence of any other messaging activity.

Expected results	If **any** AMHS message results, the IUT should fail; otherwise the IUT passes.

4.7.2.3 Example of AFTN to AMHS Conversion Test

Convert valid ITA-2 text message

CT-GW- 3	
Test Type:	Incoming valid ITA-2 AFTN message with Priority DD, an originator AF-address mapping to an MF-Address, and a recipient AF-address mapping to an MF-Address.
Description:	The tester presents the IUT with the following parameters: • an AFTN message with ITA2 text; • *DD* priority; • an originator AFTN address with an MF-Address equivalent in the IUT tables; • a recipient address with an MF-address equivalent in the IUT tables.
Expected Results:	The IUT should generate an AMHS messages with the following characteristics: • an AFTN message with ITA2 encoding; • AMHS Message Transfer Envelope priority set to *normal*; • AMHS ATS-Message-Priority-Indicator set to *DD*; • The originator and recipient's address should be take their MF-address values as configured in the IUT's; • There should be no ATS-Message-Optional-Heading-Information present in the ATS AMHS message. No AFTN messages should be generated. No error reports should be generated. Logs: • the incoming AFTN message; • the outgoing AMHS message.

4.7.2.4 Example of Invalid AFTN Message Test

Invalid AF address (i.e. not configured in the IUT)

CT-GW- 7	
Test Type:	The AFTN message contains an invalid AF address (i.e. no equivalent is configured for it configured in the IUT address mapping tables)

Description:	The tester presents the IUT with the following parameters: • an AFTN message with ITA2 encoding; • *KK* priority; • originator AFTN address with no equivalent AMHS XF nor MF OR-addresses configured in the IUT's tables.
Expected Results:	The IUT should report the error to the control position with a copy of the AFTN message.

4.7.2.5 Example of AFTN Message Acknowledgement Conversion

AFTN Acknowledgement Message with subject RN requested

CT-GW- 8	
Test Type:	This test verifies that the IUT deals correctly with an AFTN Acknowledgement Message for which the subject message's IPM receipt-notification-request was set.
Description:	The tester passes an IPM message with receipt-notification-request set to the IUT. This should result in the IUT generating its AFTN equivalent message for transit through the AFTN. The tester then passes a corresponding AFTN acknowledgement back through the IUT.

Expected Results:	Conversion of the AFTN acknowledgement into an IPN receipt-notification. The resulting AMHS IPN should have the following elements set:
	• the priority indicator should have the value urgent ;
	• the AMHS recipient-name should identify the originator of the subject IPM;
	• the originator indicator element in the AFTN message should be translated into the ipn-originator element of the Receipt Notification;
	• the Receipt Notification should have the receipt time (YYMMDDHHMMZ)set up as follows:
	  • the YY figures indicating the year should be generated by the IUT;
	  • the MM figures indicating the month should be generated by the IUT;
	  • the DD figures indicating the day should be the first two numbers from the AFTN date-time group;
	  • the HHMM figures indicating the hour and the minutes should be the last four numbers from the AFTN date-time

	group; • the IUT should add a character Z on to the end of the receipt-time element; • the resulting AMHS receipt notification should only have the ipm-preferred-recipient if it differs from the ipn-originator. It should be set to the abstract value of the O/R Descriptor of the recipient of the subject AFTN message; • the resulting AMHS receipt notification subject-ipn field should take the value of the this-IPM heading field of the subject IPM; • if the encoded-information-types differs from the originally-encoded-information-types the conversion-e it should be set to the value of the encoded-information-types of the subject IPM; • the acknowledgement-mode should be set to the abstract value *manual;* • the formal-name should be set to the converted AFTN address of the originator indicator from the AFTN service message. No error report is presented to the control position. Log Entries: • the incoming AFTN acknowledgement • the outgoing AMHS receipt notification.

4.7.2.6 Example of AFTN Unknown Address Service Message Conversion

Convert an AFTN Unknown Address Service Message where the subject message previously traversed the IUT

CT-GW-11	
Test Type:	To verify correct conversion of an AFTN Unknown Address Service Message into a non-delivery report where the subject message has previously traversed the IUT.
Description:	The tester presents the IUT with a valid subject AMHS message. The tester then presents the IUT with a related AFTN Unknown Address Service message with the following parameters: • the AFTN service message is a direct consequence of the original AMHS subject message; • The AFTN service message’s unknown addressee indicators which caused generation of the AFTN service message can be found in the IUT’s address tables; • The AFTN unknown address indicators have valid MF address mappings in the IUT’s address tables;

	• The *originator-report-request* of the subject message is **not** set to *report* (note: meaning that a delivery report would have been generated); • The *originating-MTA-report-request* of the subject message is **not** set to *report* nor *audited report* (note: meaning that a delivery report would have been generated.; • No previous delivery report has been generated for the same subject message and the same recipient.
Expected Results:	Generation of a non-delivery report with the following parameters: • *non-delivery-reason-code* set to ”unable to transfer”; • *non-delivery-diagnostic-code* set to ”unrecognised-OR-name”.

4.7.2.7 Example of Conversion of AMHS IPM Message to AFTN

Single ‘IA5-text’ body part to a Distribution list where conversion is required

CT-GW- 15	
Test Type:	Convert a valid IPM message with a single ‘IA5-text’ body part addressed to an AMHS Distribution List with the ATS-optional-Heading-Info absent.
Description:	A valid IPM message is presented to the IUT with the following parameters: • An IPM-1984 content type; • A single ia5-text IPM body part; • A single OR-Address of the Distribution List for which the IUT is *responsible*; • The distribution list contains less than 21 recipient addresses; • the abstract value of the implicit-conversion-prohibited in the message transfer envelope not set to *prohibited*; • the abstract-value of the conversion-with-loss-prohibited set to *allowed;* • a text structure in the body part which complies with SARP 3.1.2.2.3.2., and a punctuation character not allowed in Annex 10 is present in the text, and at least one line should be longer than 69 characters; • the length of the ATS-Message-text element is less than 1800 characters; • the message priority is set to normal; • the originating-MTA-report-request element is set to either *report* or *audited report* or the originator-report-request element is set to *report.*

Expected Results:	Verify that the following AFTN Messages have been generated:
	
	• an AFTN message containing an AFTN address for each recipient member of the distribution list;
	
	• the originator's OR-address should have been correctly translated into an AFTN equivalent;
	
	• the value of the priority in the AFTN message should be the same as that in the ATS-Message-Priority Element in the AMHS message ;
	
	• the value of the filing time in the AFTN message should be the same as that in the ATS-Message-Filing Time Element in the AMHS message;
	
	• The AFTN message text part should contain the ATS-Message-Text of the AMHS message as follows:
	
	    • any character which is not in the IA5IRV character repertoire should have been converted into an IA5IRV upper case character according to locally set down rules;
	
	    • any unauthorised character(s) should be replaced by the question mark character (?);
	
	    • lines of over 69 characters should have been folded;
	
	    • a Start-of-Heading character has been created by the IUT;
	
	    • the Transmission Identifier has been created by the IUT;
	
	    • There is no ATS-Optional-Heading-Info present;
	
	    • The AFTN message should have an AFTN priority set to *DD* or *FF*.
	
	The incoming AMHS message should be logged;
	
	The outgoing AFTN message should be logged.

4.7.2.8 Example of Reject AMHS PDU Test

Non-IPM 84 nor IPM 88 message

CT-GW- 26	
Test Type:	Reject non-IPM 84 or IPM 88 messages
Description:	The tester presents the IUT with an EDIM message, with the content type set to ”35”.
Expected	A non-delivery report is generated with the following parameters:

Results:	• *non-delivery-reason-code* set to ”unable-to-transfer”; • *non-delivery-diagnostic-code* set to ”content-type-not-supported”; Logs: The subject message and generated non-delivery-report are both logged; The error is reported to the control position.

4.7.2.9 Example of AMHS Receipt Notification Conversion Test

Convert an RN into an AFTN Acknowledgement

CT-GW- 43	
Test Type:	Convert a valid RN into an AFTN Acknowledgement
Description:	The tester presents the IUT with an IPN Receipt Notification which is in response to a subject AMHS message which was previously converted by the IUT with the following parameters: • a content type of IPM 1988; • a priority indicator of ”SS”;

Expected Results:	The AMHS RN should be converted into an AFTN Acknowledgement Service Message with the priority set to ”SS”.
	
	The date-time group should take the value of the six characters between and including the fifth and tenth characters of the receipt-time element of the AMHS receipt notification being converted.
	
	The acknowledgement message should have a text message made up of:
	• the procedure signal R;
	• the origin line which is made up of:
	  • the filing time;
	  • originator indicator.

4.7.2.10 Example of AMHS Non-delivery Report Conversion Test

Non-delivery report conversion

CT-GW- 46	
Test Type:	Valid Non-delivery report conversion into an AFTN unknown Address Service Message
Description:	The tester presents the IUT with a non-delivery-report for which the IUT previously generated an AMHS message. It should be set up as follows: • there is no originally-intended-recipient-name present which

	differs from the value of the actual-recipient-name; • O='AFTN'; • OU1 contains a valid AFTN address syntax; • the non-delivery diagnostic was 'unrecognised-OR-name'.

Expected Results:	The Non-delivery-report should be converted into an AFTN Unknown Address service message.
	The service message should take the same priority value as the subject AFTN message.
	The service message should have the addressee indicator set to the originator indicator of the subject AFTN message.
	The AFTN service message should have the filing time set to the time at which the IUT generated the service message. The format of the filing time should be in compliance with Annex 10, Volume I, 4.4.15.2.2.1
	The service message should have the originator address set to the AFTN address given to the AFTN component of the IUT. The service message should have the message text set as follows:
	• line one should be made up of the following:
	  • the abbreviation SVC;
	  • the procedure signal ADS;
	  • the origin of the message in error, i.e. the filing time and the originator indicator of the AFTN subject message;
	  • an alignment function.
	• line two should be made up of the following:
	  • the line following the heading of the message as received, i.e. the priority of the message followed by the addresses to which the message was originally being sent;
	  • an alignment function.
	• line three should be made up of the following:
	  • the indication UNKNOWN;
	  • the unknown addressee indicator;
	  • the end of text signal.
	One of the following conditions must be met by the AFTN service message:
	• the unknown addressee indicator should be assigned the value of the first element of the organisational-unit-names in the actual-recipient-name of the NDR, if this value is syntactically correct

	for an AFTN address and the organisation-name is set at *AFTN;* • the unknown addressee indicator should be assigned the value of AFTN address which has been retrieved from the look-up table for the actual-recipient-name of the NDR; If an AFTN address cannot be determined by either of the above two methods an error should be reported to the Control Position. The Non-Delivery Report and MF-Address should also be passed to the Control Position for further processing.

4.7.2.11 Example of AMHS Probe Handling Test

Probe response with an XF-recipient name

CT-GW- 51	
Test Type:	Response to a Probe
Description:	The tester presents the IUT with a Probe having the following parameters: • a content-type of IPM-1988; • a current encoded-information-type of *ia5-text*; • the abstract value of the implicit-conversion-prohibited in the message transfer envelope not set to *prohibited*; • the content length does not exceed 1800 characters; • the number of probe recipients the IUT is responsible for is 21 or less recipients; • the organisation-name attribute of each probe recipient OR-address is set to *AFTN* and the first element of the organisational-unit-names attribute is set to a value which is a syntactically correct AF-Address.
Expected Results:	The IUT generates of a single AMHS delivery-report addressed to the probe’s originator confirming possible delivery for all of the addressees cited in the original Probe.

4.7.3 Test PDUs

The following sections provide descriptions of AFTN and AMHS default PDUs. These should be used to select PDU field values for particular tests. The field values specified in the default PDUs are replaced by those values specified in the individual tests.

4.7.3.1 AFTN Message

AFTN **Message Part**	**Value**
Heading	
Start-of-Heading Character	
Transmission Identification	Three alphabetical characters followed by a serial number
Address	
Alignment Function	
Priority Indicator	GG except otherwise specified in test
Addressee Indicator(s)	As specified in test
Alignment Function	
Origin	
Filing Time	Time of creation/submission or as specified in test
Originator Indicator	As specified in test
Priority Alarm	Absent unless the priority is SS
Optional Heading Information	Absent unless otherwise specified in test
Alignment Function	
Start-of-Text Character	
Text	As specified in test, or six lines of random text, each of 69 characters
Ending	
Alignment Function	
Page-feed sequence	
End-of-Text Character	

Table 10: AFTN Message

4.7.3.1 AFTN Acknowledgement Service Message

AFTN **Message Part**	**Value**
Heading	
Start-of-Heading Character	
Transmission Identification	Three alphabetical characters followed by a serial number
Address	
Alignment Function	
Priority Indicator	SS
Addressee Indicator(s)	As specified in test
Alignment Function	
Origin	
Filing Time	Time of creation/submission or as specified in test
Originator Indicator	As specified in test
Priority Alarm	Present
Optional Heading Information	Absent unless otherwise specified in test
Alignment Function	
Start-of-Text Character	
Text	As specified in test
Ending	
Alignment Function	
Page-feed sequence	
End-of-Text Character	

Table 11: AFTN Acknowledgement Service Message

4.7.3.2 AFTN Unknown Address Service Message

AFTN **Message Part**	**Value**
Heading	
Start-of-Heading Character	
Transmission Identification	Serial number
Address	
Alignment Function	
Priority Indicator	Same as subject message
Addressee Indicator(s)	As specified in test
Alignment Function	
Origin	
Filing Time	Time of creation/submission or as specified in test
Originator Indicator	As specified in test
Priority Alarm	Absent
Optional Heading Information	Absent
Alignment Function	
Start-of-Text Character	
Text	As specified in test
Ending	
Alignment Function	
Page-feed sequence	
End-of-Text Character	

Table 12: AFTN Unknown Address Service Message

4.7.3.3 Message Transfer Envelope

Message Transfer Envelope	From Tester	From IUT
(per recipient fields)		
message-identifier		
global-domain-identifier		
country-name	F	D
administrative-domain-name	**ADMDy**	**ADMDx**
private-domain-identifier	**ICAO**	**PRMDUT**
local-identifier	Tester name + MTAName + Serial Number	IUT name + MTAName + Serial Number
originator-name	*OU1= Tester0*	*OU1= IUT0*
originator-encoded-information-types		
built-in-encoded-information-types	Test dependent	Test dependent
content-type		
built-in	Test dependent	Test dependent
content-identifier	*Any – may be used to identify a test in a sequence!*	*Any – may be used to identify a test in a sequence!*
priority	Test dependent	Test dependent
per-message-indicators		
disclosure-of-other-recipients	**Prohibited**	**Prohibited**
implicit-conversion-prohibited	**Allowed**	**Allowed**
alternate-recipient-allowed	**Allowed**	**Allowed**

per-domain-bilateral-information		
country-name	**D**	**F**
administrative-domain-name	**ADMDy**	**ADMDx**
private-domain-identifier	**ICAO**	**PRMDUT**
bilateral-information		*any*
trace-information		
trace-information-element		
global-domain-identifier		
country-name	**D**	**F**
administrative-domain-name	**ADMDy**	**ADMDx**
private-domain-identifier	**ICAO**	**PRMDUT**
domain-supplied-information		
arrival-time	Real time	Real time
routing-action		
relayed	Test dependent	relayed
extensions		
type		
standard-extension		
criticality		
value		
content-correlator		
internal-trace-information		
global-domain-identifier		
country-name	**D**	**F**
administrative-domain-name	**ADMDy**	**ADMDx**
private-domain-identifier	**ICAO**	**PRMDUT**

mta-name	Test-mta	Iut-under-test
mta-supplied-information		
arrival-time	Real Time	Real Time
routing-action		
relayed	Test dependent	Relayed
per recipient fields		
recipient-name	***Test dependent***	***Test Dependent***
originally-specified-recipient-number	**"**	**"**
per-recipient-indicators	**"**	**"**
Content	**"**	**"**

Table 13: Message Transfer Envelope

4.7.3.4 MTS Report

Relaying Arguments	
Report-identifier	Generated by the tester – tester identity + serial number
Trace-information	Generated by the tester according to its identity
Internal-trace-information	Absent
Redirection-history	Absent
Report DestinationArguments	
Report-destination-name	The originator of the subject message
Report Request Argument	
Originator-report-request	Absent
Subject Trace Arguments	
Subject-identifier	The same as the subject message

	message-identifier
Originally-specified-recipient-number	Taken from the subject message
Subject-intermediate-trace-information	Must include the IUT and the tester's trace items
Arrival-time	Time of arrival
Originator-and-DL-expansion-history	Absent
Reporting DL name	Absent
Conversion Arguments	
Converted-encoded-information-types	Absent
Supplementary Information Arguments	
Supplementary-information	Absent
Physical-forwarding-address	Absent
Subject Redirection Arguments	
Actual-recipient-name	Absent
Originally-intended-recipient-name	As specified in the subject message
Redirection-history	Absent
Content Arguments	
Original-encoded-information-types	As specified in the subject message
Content-type	As specified in the subject message
Content-identifier	As specified in the subject message
Content-correlator	As specified in the subject message
Returned-content	Absent
Delivery Arguments	
Message-delivery-lime	Time of delivery
Type-of-MTS-user	Private
Non-delivery Arguments	

Non-delivery-reason-code	Transfer-failure unless otherwise specified
Non-delivery-diagnostic-code	MTS-congestion unless otherwise specified
Security Arguments	
Recipient-certificate	Absent
Proof-of-delivery	Absent
Reporting-MTA-certificate	Absent
Report-origin-authentication-check	Absent
Message-security-label	Absent
Additional information Argument	
Additional-information	Absent unless otherwise specified

Table 14: MTS Report

4.7.3.5 Probe

Message Transfer Envelope	From Tester	From IUT
(per recipient fields)		
message-identifier		
global-domain-identifier		
country-name	D	
administrative-domain-name	**ADMDy**	
private-domain-identifier	**ICAO**	
local-identifier	Tester name + MTAName + Serial Number	
originator-name	*Tester = Tester0*	
originator-encoded-information-types		
built-in-encoded-information-types	test	

	dependent	
content-type		
built-in	test dependent	
content-identifier	*Any – may be used to identify a test in a sequence!*	
priority	***Normal***	
per-message-indicators		
disclosure-of-other-recipients	**Prohibited**	
implicit-conversion-prohibited	**Test dependent**	
alternate-recipient-allowed	**Allowed**	
Per-domain-bilateral-information		
country-name	**D**	
administrative-domain-name	**ADMDy**	
private-domain-identifier	**ICAO**	
bilateral-information		
trace-information		
trace-information-element		
global-domain-identifier		
country-name	**D**	
administrative-domain-name	**ADMDy**	
private-domain-identifier	**ICAO**	
domain-supplied-information		
arrival-time	Real time	
routing-action		
relayed	Test	

	dependent	
extensions		
type		
standard-extension		
criticality		
value		
content-correlator		
internal-trace-information		
global-domain-identifier		
country-name	**D**	
administrative-domain-name	**ADMDy**	
private-domain-identifier	**ICAO**	
mta-name	Test-mta	
mta-supplied-information		
arrival-time	Real Time	
routing-action		
relayed	Test dependent	
per recipient fields		
recipient-name	***Test dependent***	
originally-specified-recipient-number	**”**	
per-recipient-indicators	**”**	
Content Length	**”**	

Table 15: Probe

4.7.3.5.1 IPM ATS-Message

IPM Structure

Heading	
this-IPM	
IPMIdentifier	
user	**Originator identifier**
user-relative-recipient	
originator	
ORdescriptor	
formal-name	**OR-Name of the originator**
primary-recipients	
RecipientSpecifier	
recipient	**OR-Name of the recipient**
notification-requests	
rn	**Absent unless P1 priority is urgent**
nrn	**Absent**
Body	
ia5-text	
parameters	
repertoire	
data	
ATS-Message-Header	
start-of-heading	
ATS-Message-Priority	
priority-indicator	**Test dependent**

ATS-Message-Filing-time	
filing-time	**At test time**
ATS-Message-Optional-Heading-Info	
Optional-Heading-Information	**Test dependent**
end-of-heading-blank-line	
start-of-text	
ATS-Message-text	Six lines of random text, each of 69 characters

Table 16: IPM ATS-Message

4.7.3.6 IPM receipt – notification

subject-ipm	m	As for subject message
ipn-originator	o	As for originator of the IPM
ipm-intended-recipient	o	Address of the intended recipient
conversion-eits	o	Absent
notification-extensions	o	Absent
receipt-time	m	At delivery
acknowledgement-mode		manual
suppl-receipt-info	o	Absent
rn-extensions	o	absent

Table 17: IPM receipt – notification

4.7.3.7 IPM non-receipt - notification

IPN field		Value
subject-ipm	m	As for subject message
ipn-originator	o	As for originatorof the IPM
ipm-intended-recipient	o	Address of the intended recipient
conversion-eits	o	Absent
notification-extensions	o	Absent
non-receipt-reason	m	Ipm-discarded
discard-reason	o	Absent
autoforward-comment	m	Absent
returned-ipm	m	Absent
nrn-extensions	m	absent

Table 18: IPM non-receipt - notification

4.7.4 IUT Configured Parameters

4.7.4.1 MF OR-Address specifications

Prior to testing, the IUT MD and user address tables should be configured with address tables representing the following equivalences between AFTN and AMHS addresses:

No.	AFTN Addr	MHS OR-address equivalent						
		Co	**ADMD**	**PRMD**	**O**	**OU1**	**OU2**	**CN**
1	ICAOxx01	B	” ”[17]	AAA	1	a	x	AFT-1
2	ICAOxx02	B	” ”	BBB	2	b	w	AFT-2
3	ICAOxx03	B	” ”	CCC	3	c	v	AFT-3
4	ICAOxx04	B	” ”	DDD	4	d	u	AFT-4
5	ICAOxx05	B	” ”	EEE	5	e	t	AFT-5
6	ICAOxx06	B	” ”	FFF	6	f	s	AFT-6

[17] ” ” Corresponds to the single Space ADMD Name convention

7	ICAOxx07	B	” ”	GGG	7	g	r	AFT-7
8	ICAOxx08	XX[18]	BTI	HHH	8	h	q	AFT-8
9	ICAOxx09	XX	Belgaco	HHH	9	I	p	AFT-9
10	ICAOxx11	S	” ”	aaa	0	j	o	AFT-10
11	ICAOxx12	S	” ”	bbbb	11	k	n	AFT-11
12	ICAOxx13	S	” ”	ccc	12	l	m	AFT-12
13	ICAOxx14	S	” ”	ddd	13	m	l	AFT-13
14	ICAOxx15	S	TELIA	eee	14	n	k	AFT-14
15	ICAOxx16	S	TELIA	eee	15	o	j	AFT-15
16	ICAOxx17	J	” ”	fff	16	p	I	AFT-16
17	ICAOxx18	J	” ”	ggg	17	q	h	AFT-17
18	ICAOxx19	J	” ”	hhh	28	r	g	AFT-18
19	ICAOxx20	J	NTT	iii	29	s	f	AFT-19
20	ICAOxx21	J	NTT	iii	20	t	e	AFT-20
21	ICAOxx22	US	ATT	jjj	21	u	d	AFT-21
22	ICAOxx23	US	” ”	kkk	22	v	c	AFT-22
23	ICAOxx24	US	” ”	lll	23	w	b	AFT-23
24	ICAOxx25	US	MCI	mmm	24	x	a	AFT-24

Table 19: MF OR-Address specifications

[18] XX Corresponds to the empty Country Name convention

No.	MHS OR-Address							AFTN Address
25	**Co**	**ADMD**	**PRMD**	**O**	**OU1**	**OU2**	**CN**	
26	B	” ”	AAA	1	a	x	MHS-1	TXAOxx01
27	B	” ”	BBB	2	b	w	MHS-2	TXAOxx02
28	B	” ”	CCC	3	c	v	MHS-3	TXAOxx03
29	B	” ”	DDD	4	d	u	MHS-4	TXAOxx04
30	B	” ”	EEE	5	e	t	MHS-5	TXAOxx05
31	B	” ”	FFF	6	f	s	MHS-6	TXAOxx06
32	B	” ”	GGG	7	g	r	MHS-7	TXAOxx07
33	XX	BTI	HHH	8	h	q	MHS-8	TXAOxx08
34	XX	Belgaco	HHH	9	I	p	MHS-9	TXAOxx09
35	S	” ”	aaa	0	j	o	MHS-10	TXAOxx11
36	S	” ”	bbbb	11	k	n	MHS-11	TXAOxx12
37	S	” ”	ccc	12	l	m	MHS-12	TXAOxx13
38	S	” ”	ddd	13	m	l	MHS-13	TXAOxx14
39	S	TELIA	eee	14	n	k	MHS-14	TXAOxx15
40	S	TELIA	eee	15	o	j	MHS-15	TXAOxx16
41	J	” ”	fff	16	p	I	MHS-16	TXAOxx17
42	J	” ”	ggg	17	q	h	MHS-17	TXAOxx18
43	J	” ”	hhh	28	r	g	MHS-18	TXAOxx19
44	J	NTT	iii	29	s	f	MHS-19	TXAOxx20
45	J	NTT	iii	20	t	e	MHS-20	TXAOxx21
46	US	ATT	jjj	21	u	d	MHS-21	TXAOxx22
47	US	” ”	kkk	22	v	c	MHS-22	TXAOxx23
48	US	” ”	lll	23	w	b	MHS-23	TXAOxx24

49	US	MCI	mmm	24	x	a	MHS-24	TXAOxx25

Table 20: AMHS based user addresses

4.7.4.2 Distribution List

The IUT should be configured to hold an AMHS Distribution List containing all of the AFTN addresses listed in Table 19. Its OR-address should be configured to be OU2=DL1.

4.7.4.3 MTA Name

The IUT’s MTA name should be configured to be ”iut-under-test”.