AERONAUTICAL TELECOMMUNICATIONS NETWORK PANEL

WORKING GROUPS 2, 3 & WGW

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EUROCONTROL Reference ATN Facility Project

Proposal for ATN SARPs and GM to take into account Requirements for Testing ATN Equipment

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Summary

This document presents the EUROCONTROL Reference ATN Facility Project that has been initiated in recognition of the fact that, due to the complexity of the SARPs and the consequence of multiple product suppliers of ATN equipment there is a need for a single reference system against which ATN products should be tested for inter-operability prior to their deployment in an operational environment. The document presents the objectives, approach and conclusions of the project to date. As a result of the project conclusions to date of proposals are made for the development of SARPs and guidance (as appropriate) to take into account the needs of testing ATN equipment.

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1.   Introduction

In recognition of the potential benefits that an air/ground and ground/ground ATN based communications infrastructure will provide and, following the adoption of the draft ATN SARPs by the ATN Panel in November 1996, a number of States/Regions and Organisations are planning ATN implementation. The ATC industry is developing initial operational ATN SARPs compliant equipment for both airborne and ground systems.

It is expected that the initial operational deployment of an ATN based infrastructure will be in the North Atlantic Region in circa 2000.

In recognition of the fact that:

- the ATN SARPs (for sound technical and operational reasons) are complex;

- that there are likely to be multiple suppliers of the various components of the ATN; and

- that each of these components will need to be sufficiently tested prior to their deployment in the operational network since they are required to inter-operate with previously deployed equipment;

the Eurocontrol Agency has initiated a project termed the "Reference ATN Project" whose primary objective is to:

"Support the approval, certification and commissioning process of operational ATN avionics and ground based ATN systems".

In brief, the RAF is expected to comprise a "Test Tool" and a number of "reference implementations" for each type of system that the Test Tool will test, e.g. it will include a reference implementation of an Air/Ground Router. In order to verify that the Test Tool is behaving correctly it is calibrated by each of the reference implementations. The RAF has been defined to support the testing of both ground based and mobile End Systems and Routers. The types of testing that it will perform are (1) interoperability (2) stress (3) robustness and (4) performance. The results of testing ATN equipment may be used by the intended end-user of the equipment in support of his overall safety case necessary for the operational deployment of the equipment.

The purpose of this paper is to:

- briefly describe the rationale for initiating the RAF project;

- present the approach and planning being adopted for the execution of the project;

- present the key findings of the project to date;

- make proposals that the development of additional SARPs and/or guidance material (as considered appropriate) takes into account the need to test ATN equipment.

2.   The Need for a Reference Facility

The primary objective of such ICAO SARPs is to ensure inter-operability between air and ground systems and adjacent ground systems. However, they do allow a certain amount of flexibility in the actual provisions that are required to be implemented based upon operational environments. Typically such flexibility is apparent in terms of whether certain communications protocols are mandatory or optional (e.g. IDRP over the air/ground link) or, at a greater level of detail whether certain features within a particular protocol are mandatory or optional.

The ultimate objective of the SARPs is, within the type of flexibility referred to above, ensure that any SARPs compliant implementation (irrespective of the selected and implemented options) will successfully inter-operate with any other SARPs compliant implementation which itself may have selected an alternative (but allowable) set of options.

Though it is recognised that the initial implementation of the ATN will be limited with a limited number of suppliers it is expected that, following demonstration of benefits gained in the first implementation, the deployment and number of suppliers will rapidly increase in a relatively short period of time.

As new systems are deployed into an operational network, they require to be tested sufficiently rigorously to ensure that:

 (1) they do not influence the operation of the existing network in any detrimental way and

 (2) they are capable of performing their intended function which would typically be in supporting role to the relaying of safety critical data.

The question is how should such systems be tested ? It is an option that systems may be tested on a bi-lateral basis. This would ultimately imply that all systems have to be tested with all systems. The systems also have to be tested under exceptional conditions. Testing a system will become cumbersome and very expensive or, when the cost are not acceptable, may be limited in scope. It also has the potential to lead to disputes between vendors as to which implementation is "correct". Reduced testing will constrain the operational usability of the ATN.

When the environment grows whereby there are both multiple suppliers for both ground based and avionics equipment the problem becomes insoluble. The subject of certification/operational approval is also extremely relevant in such a scenario. Where typically avionics systems today have been certified in isolation from ground systems and in advance of any operational deployment the situation has been recognised as one needing revision in a data link environment where both the ground and airborne systems are also critical in the transmission of safety critical ATC data.

A solution that has been perceived by the Eurocontrol ATN Internet Project for such a situation (and one that has been also solved in the GSM world) is related to the use of a "test facility" against which any given ATN SARPs equipment will be initially tested prior to its deployment in an operational environment. This ultimately results in a more cost/effective approach from a total system perspective. It also increases the confidence in the deployed systems to carry safety critical data. Furthermore the RAF will enable systems to be tested under exceptional conditions which may not otherwise be the case.

The results of RAF testing may be used in the certification/operational approval of the equipment in question in order to provide the safety regulator with evidence of the inter-operability of the equipment with a reference implementation.

3.   The Eurocontrol RAF Project

As a result of significant consideration of the above situation the Eurocontrol Agency, on behalf of its Member States, has initiated a project whose ultimate objective is to provide a Test Tool and associated Reference Implementations, the project has been named the "Reference ATN Facility" Project.

The project has been phased as follows:

Project Phase	Start	End	Deliverable
User Requirements Definition	October 1996	July 1997	RAF User Requirements Document
RAF Development	January 1998	Mid 1999	RAF (Internet)

Table 2-1 - RAF Project Phases

3.1   Scope

The initial scope of the RAF   will be limited to supporting the testing of the internet component of ATN systems. The RAF will evolve to include the necessary functionality to test equipment implementing SARPs compliant upper layers and applications.

3.2   User Requirements Definition Phase

The objective of the URD phase is to develop a User Requirements Document that will define all requirements that are to be supported by a reference test facility such as the RAF.

The primary means to achieve this objective has been through:

- a number of workshops that have been held to discuss specific issues related to a reference facility (e.g. "The Meaning of a Reference Facility", "Safety Aspects", "Routing Aspects");

- interviews with recognised experts from the world of OSI Conformance Testing, and;

- "Requirements Management Team" meetings where potential users of the RAF have been presented with findings/conclusions to date from Workshops and Interviews and have had the opportunity to endorse/redefine such requirements in addition to the possibility of introducing new requirements;

- liaison with industry initiatives e.g. ProATN, ATNSI, RTCA to resolve/discuss functionality relevant to testing ATN equipment.

In order to ensure a traceable requirements definition all minutes of the above types of meetings, in addition to a set of source documentation (e.g. SARPs), have been incorporated into a database.

IBM were contracted for the development of the URD in October 1996 and the planned completion date is July 1997. The phase will be concluded with an open "Industry Workshop" the objective of which will be to provide industry with a presentation of the URD and key issues and lessons learnt from the process.

3.3   Development Phase

The EUROCONTROL Agency plans to let a contract for the development of the RAF before January 1998 time-scale following a competitive tendering process. Based upon current assumptions, the development phase is expected to be completed by mid 1999.

3.4   Key Conclusions/Findings to Date of the URD Phase

3.4.1   RAF Objective

The high level strategic objective of the RAF has been agreed to be the following:

"Support the approval, certification and commissioning process of operational ATN avionics and ground based ATN systems".

3.4.2   Systems Under Test (SUT)

The types of systems (SUTs) that the RAF will test are:

- Ground based and airborne End Systems

- Ground based and airborne Intermediate Systems

- Ground Routing Domains

3.4.3   Subnetwork Issues

The RAF will not consider subnetworks themselves as SUTs. However, the RAF will test ATN air/ground Routers accessing Mode S, AMSS or VDL. The implication is that the RAF will itself need to implement the access functionality to these subnetworks.

3.4.4   Types of Testing to be supported by the RAF

The URD phase has identified three types of testing that the RAF should be able to support, these being:

- **Interoperability testing**

The objective of which is to assess whether the SUT is capable of successfully inter-operating with a reference SARPs compliant peer supporting varying permissible protocol profiles;

- **Robustness Testing**

The objective of which is to assess the behaviour of the SUT under abnormal operating conditions, e.g. when subjected to subnetwork errors.

- **Stress Testing**

The objective of which is to assess the behaviour of the SUT when subjected to increasing input loads to well beyond its stated capability.

- **Performance Testing**

The objective of which is to measure the performance characteristics of the SUT, e.g. transit delay, throughput, processing delay etc.

It should be noted that "conformance testing" is excluded from the above since it was considered that, prior to the submission of equipment to the RAF for testing, suppliers will themselves be required to ensure that product conforms to the SARPs and OSI protocols defined for use in the ATN as profiled by the SARPs. However, a certain amount of "conformance testing" will be implicitly conducted in the inter-operability testing category where SARPs specific features such as the use of the security label would be tested.

3.4.5   Role of the RAF in Certification/Operational Approval

The certification/operational approval of data link based systems is a topic of current study and subject to definition. Given the end-to-end nature of data communications to be supported by the ATN each sub-system in the end-to-end path needs to be subjected to a certification/approval process. The RAF project has anticipated that the results of RAF testing obtained for those ATN elements in the end-to-end path may be used as one input to the overall safety case of such elements that is presented to the appropriate certification/approval bodies. Figure 3-1, below, illustrates the context and role that the RAF could fulfil in the certification/operational approval of ATN systems.
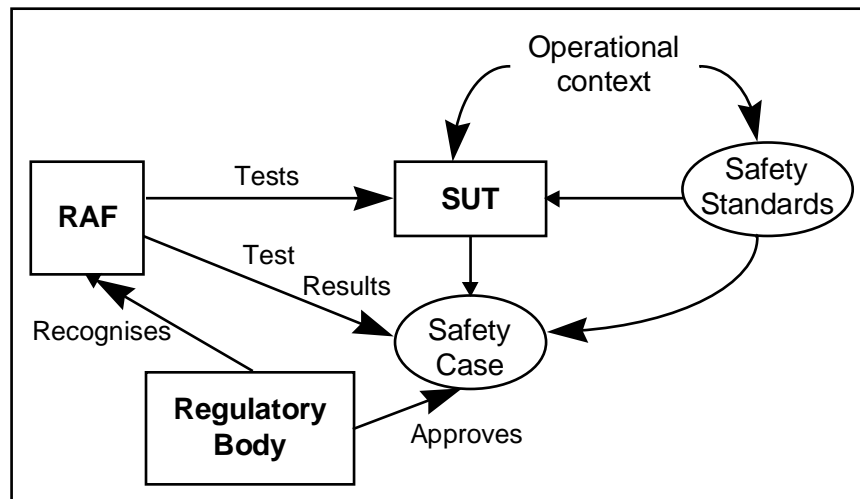
Figure 3-1 - Role of RAF in Certification/Approval

3.4.6   Relationship with ATN Systems Inc.

ATNSI have endorsed the development of the RAF facility, in note that:

"The RAF will provide a cost-effective mechanism to support system validation and certification of ATN system components. The capability to use common test tools to qualify system components for meeting safety and interoperability requirements is a fundamental element of the ATNSI program plan and certification policy" .

It is intended that there will be on-going co-ordination between ATNSI and Eurocontrol in order to ensure that the common objectives of the facility are fulfilled in order to minimise development costs of ATN systems and maximise compatibility among international ATN system developments.

3.5   Issues for the Attention of ICAO ATNP

In formulating the requirements that are applicable to a reference facility, and in the context of the ATNP/2 agreed principle that ATNP should as a priority work item support operational implementation of the ATN, the following areas have been identified where additional SARPs and/or guidance material (as appropriate) should be developed as a high priority activity:

- **Systems Management**

The current draft ATN SARPs do not define provisions for systems management support in terms of managed objects and access mechanisms. In order to provide a higher detail of test coverage of systems to be tested it has been concluded that the RAF (or indeed any test tool) will require access to certain types of information in the SUT which would be

typically tagged as managed objects. For example, in order to test the route distribution function of an ATN Router it is essential for the test function to have access to the Routers Management Information Base (MIB) which would typically be provided through a systems management interface. It is clear that, irrespective of whether the RAF ever materialises, there is a need for an appropriate set of systems management functions to be defined and current industrial initiatives are already considering appropriate means and mechanisms. From the RAF perspective, and that of the industry developing equipment for their own testing purposes, it would be beneficial for systems management standards to be defined as a high priority activity.

- **Mobile Subnetwork Interfaces**

The ATN SARPs place certain requirements on access to mobile subnetworks in terms of network layer access, in particular for mobile subnetworks, the ISO 8208 network layer protocol is compliant. However, the SARPs correctly do not define any requirements as to precisely what the interface should be in terms of the physical and data link layers and a profiling of the network layer since this is considered a local matter. Given that the RAF will need to test SUTs supporting mobile subnetwork access it will itself need to implement/emulate the access mechanisms. In the absence ofa common approach, there are numerous interfaces that could be used by various implementations and the RAF will need to implement them all. In order to limit the possible number of interfaces adopted it is considered that guidance material on the subject should be developed for each of the mobile subnetworks defined.

- **Testing ATN End Systems**

As indicated above the RAF will initially be developed to test the internet component of SUTs. In order to test an End System access is required to the transport interface may be embedded within the host system and therefore may not be externally visible to support testing.   After having discussed various solutions to the problem it was concluded that the optimal solution would be for SUTs to house a "test responder" function that would reside on the transport layer interface. It is planned to discuss this approach further with current industry initiatives developing ATN equipment in order to agree (1) the philosophy and (2) the requirements on such a test responder. From the ATNP perspective it is proposed that guidance material to support the testing of ATN equipment be developed so that future developments may take it into account.

4.   Conclusions

The need for a reference system to test ATN equipment prior to operational deployment has been discussed. The Eurocontrol RAF project approach in terms of its objectives, the URD and Development Phases has been described. The key conclusions of the URD phase to date have been presented and issues related to the further development of ATN SARPs and guidance material based upon the URD phase presented.

In summary, it can be concluded that the RAF has the potential to provide the aeronautical community with an invaluable tool that will assist the certification/operational approval of ATN equipment and lead to an efficient and manageable approach for the introduction of new ATN equipment into the existing network.

5.   Proposal

In the development of ATN SARPs and guidance material to date there has been little or no attention to the issue of testing SARPs compliant equipment. Normally such issues are considered outside the scope of SARPs and are typically dealt with "MOPS" type documents. However, due to:

- the global nature of the ATN

- the fact that there are likely to be multiple suppliers of both avionics and ground based equipment and

- that the ultimate objective of ICAO SARPs and guidance is to ensure inter-operability between airborne and ground systems

it is proposed that that the appropriate ATNP WG develop SARPs and/or guidance material as appropriate as proposed below.

It is proposed that the WG:

(1) note the plans for the development of a reference test facility, namely the RAF, in the context of supporting operational implementation of the ATN;

(2) in the development of Systems Management SARP and guidance material takes into account requirements derived from testing;

(3) develop guidance material related to the interfaces for mobile subnetworks taking into account industry developments and test requirements;

(4) develop guidance material related to Test Responders taking into account industry developments and test requirements;

(5) develop guidance material related to testing of ATN equipment.