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AERONAUTICAL TELECOMMUNICATIONS NETWORK PANEL

WORKING GROUP 2

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CNS/ATM-1 Package Internet SARPs Validation Objectives

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SUMMARY

This document defines high level validation objectives for the CNS/ATM-1 Package Internet SARPs.

This document is a modified version of WG2/WP 201. It contains proposed changes for approval at WG2/8 meeting in Bruxelles. All changes are marked up and summarised in section 1.1.

DOCUMENT CONTROL LOG

SECTION	DATE	REV. NO.	REASON FOR CHANGE OR REFERENCE TO CHANGE
All	11-May-95	Issue 1.0	Creation
All	15-Jan-96	Issue 2.0	Reissue after STA Meeting #11
All	12-Apr-96	Issue 3.0	Proposed changes before ATNP WG2/8

TABLE OF CONTENTS

1. Introduction

This document defines high level validation objectives for the CNS/ATM-1 Package Internet SARPs. These objectives have been developed in the context of the European Validation Strategy.

It is the intention of Eurocontrol to maintain this document throughout the validation process so as to contribute to the ATN Validation Report to be submitted to the ATN Panel.

1.1 Introduction to Issue 3~~2~~.0

~~This new issue of the document consolidates the work produced under EURATN Task 4 on Harmonisation Studies. The source document is referenced SIT_4.0_WD_01, Version 3.0, 13 September 1995. It also takes into account comments received on these documents.~~

~~As this issue is a contribution to ATNP WG2, a conclusion section has been added. This section makes recommendations on the progression of this document and associated validation work.~~

Issue 2.0 of the validation objectives document was submitted at ATNP WG2/7 in Brisbane and was accepted as the basis for the WG2 ATN Validation Report. The document will be maintained in ATNP WG2.

This issue 3.0 has been produced based on comments made by the European Validation Task members coordinated by EUROCONTROL. No other comments were received at the date the document was produced.

The proposed changes and justifications are as follows:

Objective	**Change**	**Justification**
AVO_205 AVO_206	modified new	The mechanisms specific to IDRP communications between BISs belonging to the same Routing Domains must also be addressed. AVO_205 is now targeted at inter-domain comms and new AVO_206 to internal comms.
AVO_231 AVO_233	modified new	The nature of the subnetwork initiation mechanisms (event-driven or polled) impact the procedures involved. AVO_231 is modified to address event-driven subnetworks. New AVO_233 addresses polled subnetworks.
AVO_232 AVO_234	modified new	The nature of the subnetwork initiation mechanisms (event-driven or polled) impact the procedures involved. AVO_232 is modified to address event-driven subnetworks. New AVO_234 addresses polled subnetworks.
AVO_410	deleted	Although some procedures are defined in ISO 10747 for maintaining RIB integrity, the problem of RIB corruption and route error propagation is considered to be a system design/validation issue rather than a SARPs validation issue: a) assuming main memory RIB implementation, RIB corruption is as probable as any other program/data corruption. b) if routes are corrupted and corruption is undetected, IDRP assumes the routes are valid, hence they are propagated.
AVO_428	deleted	Unspecific. Seems to be addressed by other objectives.
AVO_429	modified	More precise wording of the objective.

AVO_435	modified	New wording no longer introduces the arbitrary 50% increase. The formulation is now oriented towards graceful degradation of performances.
AVO_444	modified	'reliability' is inappropriate.
AVO_470 AVO_471 AVO_472 AVO_473	new new new new	Additional objectives defined as a consequence of the ATNP WG2 decisions on congestion management and new SARPs requirements.
AVO_453	deleted	Mapping between transport and network priorities is now fixed.
AVO_454	modified	Reference to 'both compression mechanisms' was incorrect. New wording addresses all the possible combinations to be validated.
AVO_455	modified	typo.

2. Approach and Conventions

2.1 Approach

The validation objectives in this document are classified according to the criteria which are identified for ATN validation. Criteria define why a given validation objective/exercise increases the validation level of a (set of) ATN requirements. Four criteria have been defined in this document:

- Criteria 1: has the requirement been implemented?
- Criteria 2: do ATN systems interoperate?
- Criteria 3: does the ATN satisfy User Requirements?
- Criteria 4: does the ATN perform *well*?

2.1.1 Criteria 1: has the requirement been implemented?

ATN SARPs must be **implementable** in ATN systems and procedures. Evidence of this will be given by the various developments under way. Exercises are necessary to ensure that all ATN requirements have been implemented in at least two distinct implementations. The contribution of these exercises to the overall ATN Validation is: "the following ATN requirements have been implemented in development *X* by *Y*".

Candidate validation exercises to assess this criteria include:

- Analysis: review of acceptance reports, qualification reports, etc. available for the systems where requirements have been implemented.
- Experiments: limited experiments targeted at demonstrating the implementation of the requirement(s).

This document does not recommend the development of experiments dedicated to the validation of this criteria. In case no evidence is found that a given (set of) requirement(s) has been implemented, its presence in the SARPs must be justified.

2.1.2 Criteria 2: do ATN systems interoperate?

ATN SARPs must lead to **interoperable** profiles. This has been assessed up to a certain point by analysis during SARPs editing. Exercises are necessary to ensure that ATN requirements lead to implementations that interoperate. This is particularly important for parts of the SARPs which have been designed especially for the ATN.

Another issue to be considered under this criteria is the impact of choosing different sets of recommendations or options in a given interworking setup.

Candidate validation exercises to assess this criteria include:

- Analysis: review of PICS
- Experiments: verification that a set of requirements lead of interoperable systems. Breakdown of this set into individual experiments depends on available platforms.
- Simulations: detailed models may be used in some specific cases to assess interoperability.

This document recommends that simulation is used only for cases that cannot be demonstrated in experiments using real implementations.

2.1.3 Criteria 3: does the ATN satisfy User Requirements?

A number of User Requirements have been described in document ATNP WG2 WP/87. Exercises are necessary to ensure that these user requirements are satisfied.

Candidate validation exercises to assess this criteria include:

- Experiments
- Simulations

2.1.4 Criteria 4: does the ATN perform *well*?

There is no written criteria about the performance expectations for the ATN. Yet, the properties of ATN protocols and of ATN network topologies will be an important element in the ATN evaluation.

Many performance figures that can be measured in ATN networks are relative to system performance or to data link capacity. In principle, these figures can be scaled to meet any performance target by appropriate system/network design.

Some performance figures are ATN intrinsics, e.g. average protocol overhead, and can be evaluated on experimental systems or through simulation.

Expected results is this area are not of a pass/fail nature. They provide indications on which ATN validation will be assessed.

Candidate validation exercises to assess this criteria include:

- Experiments
- Simulations

Experimental and simulation results should be consistent. Simulation results can be confirmed by equivalent experiments in small configurations. This is a way to assess the validity of the simulation results obtained for larger configurations.

2.2 Coverage

The set of validation objectives defined in this document is meant to be complete in terms of SARPs coverage. Although new additional criteria and objectives could be defined, the current set is considered to provide the acceptable level of coverage. In other words, the ATN Internet SARPs will be considered validated after successful verifications and executions of exercises derived from those objectives.

The details and depth of the verifications required are subject to external assessment as described in section 2.4 below.

2.3 Conventions

Objectives are stated, as much as possible, in the form of sentences beginning with verbs like "verify", "show", "evaluate", etc. Being high level statements they are not meant to describe in detail the technical steps involved. In principle, one objective is expected to be refined into one or several validation exercises.

A unique reference of the form "AVO_nnn" is assigned to each objective. This reference will not be modified in subsequent releases of this document. It is intended for use in exercise specifications.

AVO reference numbers do not necessarily appear as increasing consecutive numbers.

Validation objectives are presented in table format as follows:

Reference	*Objective Description*	*Database Ref.*
AVO_nnn	Verify that ...	ARLnnn/APRLnnn

Database References are provided when significant to an objective. No database relationship indicates that the objective is meant to validate a global property of the ATN.

2.4 Assessment

Normally, objectives state what is to be verified in order to derive a pass/fail verdict. However, it is not practical, nor even possible, to detail in this document the exact degree and depth of verification that is required in order to declare an objective met. Similarly, this document does not specify the number and type of topologies/configurations that should be tested (for an objective related to ATN routing topologies for example).

These issues are considered to be part of an assessment process, which needs to be set up in parallel with the development and execution of validation exercises. The assessment process is responsible for:

- deciding which ATN requirements can be considered as validated without any specific exercises and provide justification for it.

- deciding for each objective what is the minimum number/type of exercises that are required in order to consider the objective validated. For example: need for two distinct implementations, the significant ATN profiles to be experimented, the combination of options to be tested, the configurations for which simulation is sufficient.

- deciding what are the ATN topologies/configurations to be investigated.
- specifying target values for ATN properties and performances.
- relating actual validation exercises/results derived from these objectives to ATN database entries.

3. Validation Objectives

3.1 Implementation of ATN systems and procedures (criteria 1)

All the following exercises are meant to be conducted through analysis of existing documentations and reports: PICS, acceptance test reports.

The expected outcome is an indication of the ATN requirements that have been successfully implemented. As a result, some coverage analysis can be derived from these exercises.

In these exercises, the term ’ATN requirements’ is used to refer to mandatory requirements and to recommendations. The ATN options, as derived from PRLs, can be considered as out of the scope of these exercises. However, ATN options may be the subject of additional validation exercises to verify that they are neither needed nor "dangerous" to the ATN service when implemented.

The term ’implemented’ in this context is not restricted to ’implemented in operational/avionics systems’. Prototypes and pre-operational are also capable of validating the ’implementability’ of SARPs. The degree of confidence required, hence the type of implementation, is an issue for the assessment procedure to establish (see 2.4).

3.1.1 Ground End System

AVO_101	Verify that all ATN requirements pertaining to ground End Systems have been implemented and demonstrated to be SARPs compliant.	ARL401 ARL402 ARL403 ARL500 ARL700 APRL101-155 APRL201-211

3.1.2 Airborne End System

AVO_102	Verify that all ATN requirements pertaining to airborne End Systems have been implemented and demonstrated to be SARPs compliant.	ARL401 ARL402 ARL403 ARL500 ARL700 APRL101-155 APRL201-211

3.1.3 Ground-Ground BIS

AVO_103	Verify that all ATN requirements pertaining to ground-ground Boundary Intermediate Systems have been implemented and demonstrated to be SARPs compliant.	ARL500 ARL600 ARL602 ARL700 APRL201-202 APRL251-270 APRL401-414

3.1.4 Air-Ground BIS

AVO_104	Verify that all ATN requirements pertaining to air-ground Boundary Intermediate Systems have been implemented and demonstrated to be SARPs compliant.	ARL500 ARL600-602 ARL700 APRL201-202 APRL251-270 APRL301-305 APRL401-414 APRL501-515 APRL601-604

3.1.5 Airborne BIS supporting IDRP

AVO_105	Verify that all ATN requirements pertaining to airborne Boundary Intermediate Systems supporting IDRP have been implemented and demonstrated to be SARPs compliant.	ARL500 ARL600-602 ARL700 APRL201-202 APRL251-270 APRL301-305 APRL401-414 APRL501-515 APRL601-604

3.1.6 Airborne BIS without IDRP

AVO_106	Verify that all ATN requirements pertaining to airborne Boundary Intermediate Systems not supporting IDRP have been implemented and demonstrated to be SARPs compliant.	ARL500 ARL601-602 ARL700 APRL201-202 APRL251-270 APRL301-305 APRL501-515 APRL601-604

3.1.7 ATN Subnetworks

AVO_108	Verify that ISO 8802-2 LAN subnetworks have been implemented for support of ATN communications and demonstrated to be SARPs compliant	ARL040 ARL700

AVO_109	Verify that ISO 8208 WAN subnetworks have been implemented for support of ATN communications and demonstrated to be SARPs compliant	ARL040 ARL700
AVO_110	Verify that ISO 8208 Point-to-Point subnetworks have been implemented for support of ATN communications and demonstrated to be SARPs compliant	ARL040 ARL700
AVO_111	Verify that Mode S subnetworks have been implemented for support of ATN communications and demonstrated to be SARPs compliant	ARL040 ARL700
AVO_112	Verify that Satellite subnetworks have been implemented for support of ATN communications and demonstrated to be SARPs compliant	ARL040 ARL700
AVO_113	Verify that VHF subnetworks have been implemented for support of ATN communications and demonstrated to be SARPs compliant	ARL040 ARL700
AVO_114	Verify that CIDIN subnetworks have been implemented for support of ATN communications and demonstrated to be SARPs compliant	ARL040 ARL700

3.1.8 Addressing

AVO_121	Verify that all ATN requirements pertaining to addressing have been implemented in ATN systems and demonstrated to be SARPs compliant.	ARL030

3.1.9 Routing architecture and policy

AVO_122	Verify that all ATN requirements pertaining to routing architecture and routing policy have been implemented and demonstrated to be SARPs compliant. This includes ATN system aspects and associated procedures.	ARL010 ARL020

3.2 Interoperability (criteria 2)

The CNS/ATM-1 Package SARPs specify the ATN Network and Transport Layers in terms of their constituent protocols and functions. They mandate certain features, recommend others and document a wide variety of options without mapping these to real world systems (e.g. Routers and Host Computers). The large number of possible combinations of standards, recommendations and options complicates the validation process.

Within each type ATN systems defined in SARPs (ES, GG-BIS, AG-BIS, A-BIS), there are a number of possible ATN compliant solutions (called hereafter ATN Compliant Profiles). A Profile is defined as a specific choice of recommendations/options allowed by the SARPs. Validation must prove that all these possible profile solutions inter-operate. When this is not the case, the ATN SARPs must be in error and cannot be validated as they stand.

Experiments will contribute to the definition of a practical number of interoperable ATN components of various types (e.g. air-ground Router, ground-ground Router, ATC Host Computer etc.) by identifying ATN Compliant Profiles for them. These Profiles will be constructed from the standards, recommendations and options specified in the ATN SARPs.

Assuming that a set of inter-operable ATN components has been developed, the validation process will continue by examining the operation of a number of ATN components in various topologies to demonstrate the stable operation of the ATN.

Interoperability objectives are divided into two main families:

1) peer to peer interoperability objectives concentrate on the dialogue between two systems and the service provided by those two systems.

2) multi-peer interoperability objectives concentrate on network-wide properties of the ATN which involve an arbitrary number of systems. Note that these objectives do not address multi-peer user application concepts.

3.2.1 Peer to peer interoperability

3.2.1.1 Data transfer

Data transfer exercises should investigate various transport user situations. Depending on the tool used, transport users may be:

- raw data exchanges with no relationship to ATN transport users. This data exchange type only serves the purpose of demonstrating the transport provider capabilities. It should not be used to demonstrate the ATN capability to support any specific ATN user type.

- models of ATN transport users. These data exchanges can be tailored to reflect the characteristics of real application behaviours. These models include setting of average messages length, time distribution patterns, etc.

- prototype/real applications using ATN transport service. These data exchanges can be used in demonstration of capability to support ATN user applications.

3.2.1.1.1 Default interworking profiles

AVO_201	Verify that two compliant ATN End Systems interoperate and provide Connection-Oriented Transport Service to Transport Service users. These End Systems should be configured so as to obey a default ATN profile (subsequent validation exercises will investigate different profile combinations). The exercise(s) based on that objective should address: connection establishment, one-way data transfers, two-way data transfers, expedited data transfer, normal disconnection, multiple simultaneous connections. *Note: several experiments will have this exercise as a prerequisite. Data transfers will be used to test various network conditions and to exercise ATN systems.*	ARL401 ARL402 APRL101-138
AVO_202	Verify that two compliant ATN End Systems interoperate and provide simultaneous Connection-Oriented and Connectionless Transport Services to Transport Service users.	ARL401 ARL402 ARL403 APRL101-155

3.2.1.1.2 Varying protocol profiles

AVO_203	Verify that two compliant ATN End Systems supporting different protocol profiles (support of ATN recommendations) interoperate and provide the Transport Service. Several exercises are needed to investigate different transport and network options. The exercises should address: TPDU size negotiations including use of new parameter "preferred maximum TPDU size", use/non-use of checksum, extended format and associated data transfers, selective acknowledgement (both transfer formats), request for acknowledgement (both transfer formats).	ARL401 ARL402 ARL403 APRL101-155

3.2.1.1.3 Varying subnetwork configurations

AVO_204	Verify that two compliant ATN End Systems interoperate and provide the Transport Service across multiple subnetworks. Multiple subnetwork configurations should include: a) one LAN - *n* ground point-to-point links (or WAN) - one LAN b) one LAN - *n* ground point-to-point links (or WAN) - Mode S - one LAN c) one LAN - *n* ground point-to-point links (or WAN) - Satellite - one LAN d) one LAN - *n* ground point-to-point links (or WAN) - VHF - one LAN	ARL401 ARL402 ARL403 APRL101-155

3.2.1.2 Inter-domain ground-ground routing

AVO_205	Verify that ground-ground BISs from different Routing Domains with different IDRP/CLNP profiles stating compliance to the ATN Draft SARPs can interwork at the functional level. This objective~~exercise~~ is meant to verify the various aspects of the BIS-BIS communication: connection establishment, routing update, route advertisement, route refresh, disconnection.	ARL500 ARL600 ARL602 APRL201-202 APRL251-267 APRL401-414
AVO_206	Verify that ground-ground BISs belonging to the same Routing Domain with different IDRP/CLNP profiles stating compliance to the ATN Draft SARPs can interwork at the functional level. This objective is meant to verify the various aspects of the BIS-BIS communication: connection establishment, routing update, route advertisement, route refresh, disconnection. It verifies also the features specific to domain internal BIS-BIS communications.	ARL500 ARL600 ARL602 APRL201-202 APRL251-267 APRL401-414
AVO_230	Verify the ground-ground BIS interworking, as in the previous objective, for various subnetwork adjacencies: LAN, point-to-point links, multiple intra-domain hops, etc.	ARL500 ARL600 ARL602 APRL201-202 APRL251-267 APRL401-414

3.2.1.3 Air-ground routing with IDRP, mobile SNDCF

AVO_231	Verify that air-ground and airborne BISs with different IDRP/CLNP profiles stating compliance to the ATN Draft SARPs can interwork at the functional level for subnetworks providing event-driven routing initiation mechanisms. This objectiveexercise is meant to verify the various aspects of the BIS-BIS communication: route initiation, connection establishment, routing update, route advertisement, route refresh, disconnection.	ARL500 ARL601 ARL602 APRL201-202 APRL251-267 APRL401-414 APRL501-515
AVO_233	Verify that air-ground and airborne BISs with different IDRP/CLNP profiles stating compliance to the ATN Draft SARPs can interwork at the functional level for subnetworks providing polled-mode routing initiation mechanisms. This objective is meant to verify the various aspects of the BIS-BIS communication: route initiation, connection establishment, routing update, route advertisement, route refresh, disconnection.	ARL500 ARL601 ARL602 APRL201-202 APRL251-267 APRL401-414 APRL501-515

3.2.1.4 Air-ground routing without IDRP, mobile SNDCF

AVO_232	Verify that air-ground and airborne BISs supporting the non-use of IDRP option can interwork at the functional level for subnetworks providing event-driven routing initiation mechanisms. This objectiveexercise is meant to verify the various aspects of the BIS-BIS communication: route initiation, ISH monitoring.	ARL500 ARL601 ARL602 APRL201-202 APRL251-267 APRL501-515
AVO_234	Verify that air-ground and airborne BISs supporting the non-use of IDRP option can interwork at the functional level for subnetworks providing polled-mode routing initiation mechanisms. This objective is meant to verify the various aspects of the BIS-BIS communication: route initiation, ISH monitoring.	ARL500 ARL601 ARL602 APRL201-202 APRL251-267 APRL501-515

3.2.2 Multi-peer interoperability

The objectives in this section require that several ATN systems participate in the provision of the expected service. The verifications concentrate on rules defined in the SARPs for dialogues between ATN systems (air-ground and ground-ground interfaces), routing topology and policies.

3.2.2.1 Adaptive routing

AVO_240	Verify that data packets follow alternate paths and maintain communication after failure of a network component.	

3.2.2.2 Stability of IDRP

AVO_241	Verify that BISs can sustain BIS-BIS connections for a long period of time to support a 'typical' routing information exchange. Typical routing traffic include a) asymmetric traffic, e.g. peripheral BIS towards backbone BIS, and b) symmetric traffic, e.g. between backbone BISs.	
AVO_242	Verify the ability of the IDRP protocol to choose the better route for a given criteria (minimal distance).	
AVO_243	Verify the stability of the IDRP: ability of IDRP to converge in the updating of the routing table in sufficient time to avoid loss of transport connections, and to maintain end-to-end QoS.	

3.2.2.3 Route initiation and Routing information propagation

AVO_244	Verify that routes to mobile domains are propagated in an ATN network in such a way that all aircraft remain reachable from any domain.	ARL020 ARL601 APRL601-604
AVO_245	Verify that in case of multiple air-ground adjacencies (multi-homed ERD), ground routers select appropriate routes to the aircraft in accordance with requested QoS/Security label.	ARL020 ARL601 APRL601-604

3.2.2.4 ATN Policy Support

AVO_246	Verify that Routing Policy Rules in the ground environment (Ground BIS and ES) guarantee proper dissemination of route information. This should be validated for a range of possible topologies including: - simple tree-like network of interconnected RDs, one backbone RD. - network of fully interconnected RDs, one backbone RD. - RDs with hierarchy of RDCs, a backbone RDC involving several RDs (different scenarios can be envisaged)	ARL010 ARL020
AVO_247	Verify that Routing Policy Rules in the air/ground environment guarantee proper dissemination of route information.	ARL010 ARL020
AVO_248	Verify that Routing Policy Rules permit the definition of separate administrative domains in a given ATN topology.	ARL010 ARL020
AVO_249	Verify that Routing Policy Rules guarantee proper dissemination of route information for topologies involving ATN Islands: - fully interconnected Islands - tree-like network of interconnected Islands (transit Islands)	ARL010 ARL020

3.3 User Requirements (criteria 3)

All the validation objectives below refer to ATN User Requirements defined in WG2 WP/87. Since this document has not been maintained it was not considered appropriate to have an exhaustive coverage of the document.

Only a subset of User Requirements have been selected. The main selection criteria has been that the user requirement was linked to an observable property of an ATN network or ATN topology. Most of the remaining User Requirements stated in WG2 WP/87 are satisfied (and hence verified) "by definition".

3.3.1 Support of various types of application

AVO_301	Verify that the ATN internet is transparent from the point of view of user applications : - ability to handle different dialogue types - ability to handle short messages as well as long messages.	
AVO_310	Verify that the ATN is capable of supporting the various types of user communications: administrative, operational, general, etc. The exercises must validate the separation of traffic in relation to policy and to network resources.	

3.3.2 Independence from the subnetwork

AVO_303	Verify the ability of the ATN service to ensure a fall back on another sub-network in case of problem on the default sub-network.	
AVO_304	Verify that pertubated sub-network (high noise condition) has no impact on the ATN service except for increase in average end-to-end transit delay.	

3.3.3 Service delivered to users

AVO_311	Verify that the ATN can deliver homogeneous, continuous and efficient service to the user from take-off to landing.	
AVO_312	Verify that the ATN can be designed to accommodate normal traffic and peak traffic. The traffic expectations are still to be defined. It is proposed that validation exercises make assumptions on what will be these traffic expectations for a given region of the ATN (e.g. Europe) and evaluate the possible ATN designs.	
AVO_313	Verify that the ATN is able to support the various types of user communications as defined by the security type parameter : - ATN Administrative communications, - ATN Operational communications, - General communications, - ATN Systems Management communications	

3.4 ATN properties and performances (criteria 4)

This section can be viewed as a list of objectives which validates the assumed or implicit User Requirements. No formal source document is available which state the expected properties/performances of the ATN.

The assessment procedure is required to define the expected values/targets against which the ATN properties and performances will be evaluated.

Until these expected values are specified, an objective of the form "Evaluate X" should be interpreted as "Evaluate X. Verify that X is acceptable". The acceptability criteria for such a general case is:

- exercises derived from this objective do not reveal SARPs inconsistencies or gaps,
- observed performances are consistent with provision of ATN user services,
- observed performances are scalable to future ATN configurations or ATN systems.

3.4.1 Routing information propagation

AVO_406	Evaluate the IDRP update propagation time (time it takes for a route to be propagated in the whole ATN for given ATN topologies). Alternatively, evaluate the probability that a given BIS is using out-of-date routing information at any time.	
AVO_407	Evaluate the impact of IDRP timers on Routing Information propagation.	
AVO_408	Evaluate the impact of the policy for route distribution (broadcast to all domains versus to backbone only) on Routing Information propagation.	
AVO_409	Evaluate the reliability of the IDRP transport mechanism (number of retransmissions, transmission errors)	
~~AVO_410~~	~~Evaluate the consequence of errors in the routing tables and the risk of propagation.~~	

3.4.2 Protocol overheads

AVO_431	Evaluate the inter-domain routing information exchange overhead for given ATN topologies and routing policies when the IDRP protocol is used over air-ground links. This should be compared to the expected available capacity (on ground and mobile subnetworks). This evaluation should be based on assumed operational scenarios.	
AVO_420	Evaluate the inter-domain routing information exchange overhead for given ATN topologies and routing policies when non-use of IDRP option is used over air-ground links. This should be compared to the expected available capacity (on ground and mobile subnetworks). This evaluation should be based on assumed operational scenarios.	
AVO_460	Evaluate the Transport/CLNP protocol overhead . This should be compared to the expected available capacity (on ground and mobile subnetworks). This evaluation should be based on assumed operational scenarios.	

3.4.3 Mobile handover

AVO_421	Show that it is possible to maintain communication between any ground system and an aircraft following a realistic flight path.	
AVO_422	Show that when there is a change in the route to an aircraft, the time taken between the loss of communication and the establishment of a replacement communications path neither results in the loss of a transport connection between the ground system and aircraft, nor does the transit delay increase beyond an acceptable minimum QoS.	
AVO_423	Show that the above holds with the simulation of many aircraft simultaneously.	
AVO_424	Verify the reliability of the service during mobile subnetworks handover conditions.	
AVO_426	Verify that in case of mobile handovers, ongoing transport connections are not terminated. The scenarios to consider include: - a new connection attempt is made when subnetwork disconnection or leave event is received. In this case the new connection attempt introduces a delay that may cause a transport disconnection. - a new connection is set up before handover occurs. This requires some knowledge either from the ground BIS or from the airborne BIS about the upcoming handover situation.	
~~AVO_428~~	~~Validate the inter-satellite handover.~~	
AVO_429	Evaluate the impact on IDRP of additional subnetwork connections between an air/ground and an airborne router, and the handover from one air/ground router to another.~~Evaluate the impact on IDRP of additional aircraft connections, aircraft handovers.~~	

3.4.4 Stability of IDRP

AVO_435	Verify that once the applied load on the ATN exceeds its design limits that network performance degrades gracefully, rather than catastrophically. In particular, verify that degraded performance is experienced in strict priority order, with performance degraded first for lower priority data, and that higher priority transport connections are not lost before lower priority transport connections following the same or a similar route. This objective may be satisfied by simulation of an example ATN Island.~~Verify that the network does not collapse with at least a 50% increase in aircraft numbers, i.e. that a point is not reached where transport connections are regularly lost each time a route changes.~~ ~~This objective can be reached by simulation choosing the IDRP update propagation times between BISs over a range to cover the possible variance of the mean propagation delay.~~	
AVO_436	Verify that the number of routing updates is consistent with the router processing capacity.	

3.4.5 End-to-end QoS

ATN systems will exhibit certain performance characteristics which depend on 1) subnetwork capacity, 2) hardware performance, 3) software performance, 4) protocol profile options and negotiated options.

The system performance will directly influence the QoS that may be expected from a given ATN configuration. These objectives are expected to provide figures that will be used in predicting the QoS delivered by future ATN configurations. Minimum acceptable QoS values need to be assessed.

AVO_441	Evaluate end-to-end QoS (e.g. Transport Service QoS as defined in ISO/IEC 8072) for relevant network configurations.	
AVO_442	Evaluate the effects of specific protocol options or implementation strategies on the end-to-end QoS. In particular: - effect of the transport acknowledgement strategy on the measured QoS - effect of transport timer values - effect of selected TPDU size - effect of subnetwork maximum SNSDU size	
AVO_443	Evaluate the impact of the traffic load on the QoS.	
AVO_444	Evaluate the service characteristics~~reliability~~ in terms of : - measurement of packet lost number - data integrity - number of retransmissions	
AVO_445	Evaluate the impact of transport parameters tuning on the QoS and performances.	

3.4.6 Congestion management

The draft ATN SARPs do not currently specify a congestion management strategy for the ATN Internet, although it does describe several alternatives. One of these alternatives needs to be chosen and mandated by the ATN SARPs.

The congestion management strategies that need to be investigated involve the transport layer alone, or the transport and network layers co-operating together. In summary, these strategies are:

a) Transport Layer Backoff: the transport protocol reacts to the need to retransmit by assuming that its transmit credit window has been lowered to one, and only gradually opens the window back up to size the receiver permits, as packets are successfully sent.

b) Source Quench: the network layer reacts to the detection on the onset of congestion (an outgoing queue length reaching some threshold value) by sending back an Error PDU to the sender, which then backs off as above.

c) Congestion Experienced Bit: the network layer reacts to the detection on the onset of congestion (an outgoing queue length reaching some threshold value) by setting the congestion experienced bit in the packet header. The receiving transport layer reacts to this by withdrawing credit from the sender.

AVO_446	Evaluate each Congestion Management strategy under realistic congestion scenarios. The evaluation should be based on high-level QoS measurements to be compared to the congested situation without congestion management strategy.	
AVO_447	Evaluate the effect of having heterogeneous support of congestion management strategies in an ATN. In particular, is it necessary that all ISs implement the requirements for a congestion management strategy to work to an acceptable level ?	
AVO_448	Evaluate the behaviour of the system in case of congestion (lack of resources at the destination node)	
AVO_449	Verify that the congestion control (congestion avoidance) prevents deadlock in the network.	
AVO_450	Evaluate the impact of congestion on the user service of communication.	
AVO_470	Evaluate the performance of receiver based congestion management over each class of air/ground subnetwork, when an adjacency is supported by more than one class of air/ground subnetwork simultaneously and when no subnetwork preference is given i.e. when an NPDU may go over any of the available subnetwork connections. The evaluation should aim to determine the conditions by which the required QoS is maintained even when congestion occurs.	
AVO_471	Evaluate the impact of congestion, when using receiver based congestion management, on transport connections with different end-to-end path lengths, but which share a congested path segment.	
AVO_472	Validate that when the receiver based congestion management algorithm is used, higher priority transport connections remain unaffected by the network congestion until the congestion reaches the point that the network service is effectively lost to lower priority transport connections.	
AVO_473	Evaluate the importance of an accurate measurement of the round trip delay for effective use of the receiver based congestion management algorithm, and the consequences of mobility i.e. when the round trip time changes significantly due to a change in the point of attachment or air/ground subnetwork used.	

3.4.7 Priority

ATN network layer packets are each given a priority (0..14), with data for safety related and network management applications being given a higher priority than the data of routine applications. Higher priority packets should then be given preferential access to network resources, such that on outgoing queues, higher priority packets are sent before lower priority packets and, when a router becomes congested, lower priority packets are discarded before higher priority packets. The intention is that when the network becomes congested, any degradation in the QoS is seen first by lower priority data, and that any degradation in the service offered to higher priority data is seen only after the service to lower priority data all but disappears.

AVO_451	Verify that high priority data have a higher probability of achieving the expected QoS. This should be verified for various level of traffic up to congested conditions. Verify that, in congested situations, the ATN delivers application messages by taking into account the priority of the message.	
AVO_452	Evaluate the QoS discrimination between high and low priority data under the various congestion management strategies.	
~~AVO_453~~	~~Validate the concept of mapping of transport priority and network priority when transport priority is used (i.e. is a fixed mapping sufficient or is there a need for user-defined mappings?)~~	

3.4.8 Compression

AVO_454	Evaluate the compression ratio of ATN~~both~~ compression mechanisms for typical user application dialogues and average routing information exchanges in the following case~~.~~ a) no compression (base reference) b) LREF only c) LREF + ACA d) LREF + V.42bis e) LREF + ACA + V.42bis	
AVO_455	Evaluate the impact of the SNDCF compression mechanisms on the ATN service performances.	
AVO_456	Evaluate the probability of use of the cancellation procedure in Air-ground communications.	

4. Conclusion

This document contains a comprehensive list of validation objectives to which current and planned validation exercises can be related. It is expected that such a common repository of objectives will permit comparison of validation contributions, and their consolidation into a common ATN Internet Validation Report.

This new edition contains amendment proposals which are the consequence of ongoing validation tasks. It is therefore recommended that:

- ATNP WG2 endorses this updated list of validation objectives and maintains it as the basis of the validation process and of the validation reporting procedure.