ATN Validation Strategy

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0. References

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"EUROPEAN Strategy for ATN Manual V2.0 Validation," H.J. Hof, et al, WP/29 ATNP WG2, San Diego, USA.
"Draft Principles and Constraints to be applied for Definition and Subsequent Validation of the Internet CNS/ATM-1 Package SARPs and Guidance Material," Flimsy 1, ATNP/WG2/1, San Diego, USA.

1. Introduction

The ATN Validation Strategy drafting group was tasked by Working Group 2 to define a strategy for ATN validation. As inputs to this work, the group was asked to consider the material presented in the above mentioned references. The work of the group was to be placed in the context of chapter 3 of WP/29. This report assumes that the definition of a package under validation has occurred.

2. The Term Validation

In the ICAO context, validation is considered complete when systems which meet user requirements to an agreed upon level of confidence can be produced from draft SARPs and Guidance Material. The following should be the goals of validation activities:

(1) Analyze the ATN draft SARPs and Guidance Material for a given package in detail to produce a consistent and identifiable set of user requirements,

(2) Form a complete definition of user requirements, including those which are not implicit to the draft SARPs and Guidance Material,

(3) Analyze the draft SARPs and Guidance Material for a given package to produce a complete, consistent, and identifiable set of technical requirements that are expected to meet the user requirements,

(4) Construct practical systems based on the technical requirements in the draft SARPs and Guidance Material for a given package and verify their correct performance according to system specification,

(5) Conduct validation exercises with the verified systems in order to validate technical requirements for a given package of draft SARPs and Guidance Material for internal completeness and consistency whilst assessing them against user requirements, and

(6) Assess output of the validation exercises with respect to a given package of draft SARPs and Guidance Material and produce SARPs validation reports.

3. Aspects of Validation

Two major activities which comprise the ATN validation process. These activities occur in parallel and require exchange of information between them. The aspects of validation apply to each category of means of validation (e.g., fit to purpose assessments). These activities are:

(1) Assessment and proof of ATN correctness, completeness, and consistency: this activity assesses the documented requirements and design of the ATN internetwork on a functional level.
Issues to be addressed in this activity include: internal consistency of the ATN draft SARPs for a given package, the ability to build ATN components as specified in the

draft SARPs for a given package, concept feasibility for a given package and the ATN internetwork, and interoperability testing of ATN internetwork components.

(2) Evaluation against user requirements: this activity assesses the ATN suitability, or fit to purpose, within its intended context of operation.
A sub task of this activity will investigate, assess, and define where necessary a set of user requirements against which to validate the ATN. This task is seen as evolutionary (i.e., the task will involve iteration with the user community and other interested ICAO Panels and working groups). The goal of the requirements sub task is to provide as much fidelity as possible in the area of user requirements.
ATN validation efforts will use the evolutionary user requirements to continually assess ATN fit to purpose. Items such as those presented in WP/8 (e.g., scope, scalability, robustness, auto-configurability, tweakability, determinsim, and migration) should be included in fit to purpose assessments.
Decisions and tradeoffs made by WG2 and its CCB should consider the fit to purpose items defined by this activity.
Note: It is recognized by the drafting group that this may likely require WG2 to "seed" the process with an initial set of user requirements from which to iterate.

4. Means of Validation

The Working Group agreed that validation itself is an evolutionary process and that to facilitate that process the following types of validation will be used:

(1) Analysis: Paper studies to investigate internal consistency and design issues of the ATN internetwork. It is recognized that tools such as the ATN Requirements Data Base are essential to this process.

(2) Simulation: Since ATN prototype components will not likely be large in number, simulation plays a key role in fit to purpose assessments. By this we mean that a small number of ATN implementation can be used to gather and assess performance data, and the simulation can then be calibrated against the "real world" results and used to extrapolate ATN performance and behaviors with a large number (e.g., thousands) of aircraft and routers.

(3) Prototyping: This activity results in the construction of prototype ATN internetwork components. The prototype components will typically be based on a mix of commercially available, developed, and modified commercial software. Prototype implementations can be developed in a rapid prototyping (i.e., evolutionary) manner. Prototypes may or may not be developed in a rigorous quality assurance environment. When rigorous methods are not employed, States and Organizations are responsible to be aware of the limitations and context of these prototype implementations.

  (a) Hybrid emulation and prototype: These implementations can be used to assess ATN performance and behavior without incurring the cost of utilizing actual air-ground and ground-ground links. Hybrid prototypes exist in laboratory settings, where measurements can be taken easily, and include a simulated means of producing the effects of aircraft mobility, network connectivity, etc. Data from this activity will be used to calibrate and validate the ATN simulation models and will facilitate more efficient target environment testing.

  (b) Prototype components: These implementations consist of laboratory implementations, yet utilize target networking components (e.g., air-ground links, ground network connectivity). Prototypes will yield valuable data concerning ATN performance and behavior in a laboratory setting where measurements can be taken easily. Data from this activity will be used to calibrate and validate the ATN simulation models and will facilitate more efficient target environment testing.

  (c) Rigorous prototyping: detailed rigorous implementation of ATN components in an environment of formal quality assurance.

(4) Target Environment Testing: Laboratory based implementations, while useful for easily generating performance and behavior data, cannot predict all of the effects of

operation in a target environment. This validation activity extends the use of prototype ATN components to the target operational environment. Target environment testing does not preclude the use of prototype components nor does it preclude the use of "commercial" products, if available. The intent of this activity is to gather and assess ATN performance and behavior data in an environment of ever increasing fidelity. Since these implementations will not likely exist in large numbers, data gathered and lessons learned from this activity will be used to calibrate and validate the ATN simulation models. Target environment testing includes the following activities:

(a) flight trials necessary to demonstrate the feasibility of ATN internetwork mobile components and to gather engineering data to be used in the evaluation of draft SARPs for a given package.

(b) ground - ground trials necessary to demonstrate the feasibility of the ATN internetwork ground components and to gather engineering data to be used in the evaluation of draft SARPs for a given package.

The four major categories of validation should be reflected in the method of validation field of the ATN Requirements Data Base.

5. Validation Required for a Given Package

ATN components will exist in commercial form at some point in the future; however, it is not likely that they will exist for a given package under validation. Therefore, the use of commercial products, or products built in the target system environment, is not required for validation of a given package of draft SARPs. However, if package n implementation exists and package n+1 is under validation, then a hybrid environment of prototype n+1 and commercial n is desirable for validation of package n+1. In this way system loading and backwards compatibility can be assessed. It should be noted, however, that such a hybrid environment must be sufficiently proven in laboratory settings to mitigate as much risk as possible prior to subjecting the package to target environment tests.

A given package requires validation through target environment testing and simulation incorporating the results of the target environment test.

6. CNS/ATM-1 Package Validation

With respect to CNS/ATM-1 Package, validation exercises performed by ICAO States and Organizations will consider the principles and constraints expressed in Flimsy 1. The validation exercises will be based upon the means of validation expressed above, with the recognition that full rigorous prototyping cannot likely be applied in the CNS/ATM-1 Package time frame. ICAO States and Organizations will present their validation results to ATNP WG2 in the context of the principles of validation described above. WG2 can then declare the contents of CNS/ATM-1 Package SARPs validated or not based upon these results.

7. Conclusions

The Working Group endorsed the following concepts described in this report and noted that it concluded WG2 deliverable WG2-5, as defined in Flimsy 5, (as reproduced in Appendix J).

(1) definition of validation,
(2) aspects of validation,
(3) means of validation,
(4) principles of validation for a given package, and
(5) principles for CNS/ATM-1 Package validation.