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WORKING GROUPS 2 & 3

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Comments on ICAO ATNP WG1/2 Report, Appendix D (Previously Flimsy 3)

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SUMMARY

This document has been prepared as the Eurocontrol Agency input on Applications Requirements and ATN Internet Functionality for the ICAO ATNP WG2/3 meetings in May 1995 in Washington.

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1. INTRODUCTION

This paper results from an analysis of ICAO ATNP WG1 Report, Appendix D (formerly known as Flimsy 3). The paper provides:-

- an item by item commentary on the original document
- a proposed distribution of requirements between applications, upper layers, the internet layers and network design.
- an illustration of current use of priority and traffic types
- an illustration of the parameters of Transit Delay

Sections 2 and 3 provide the commentary on parts 2 and 3 of the Flimsy 3 text. Section 4, 5,and 6 are new material resulting from discussion of Flimsy 3.

WG2/3 is invited to act on the content of this paper in the resolution of user requirements to application, upper layer, internet and network designers.

2. COMMENTS ON APPLICATION REQUIREMENTS

Application Requirements can be satisfied by upper layer services or by internet services or by a combination of the two. A section has been introduced (5) which proposes where requirements should be specified, and where they should be implemented for package 1.

Statement in WG1 Report, Appendix d (Flimsy 3)	Comment on Requirement
2.1 General Design Requirements.	
Transit Delay shall be specified as a design parameter, for each application	The 'Application SARPs' should normally specify up to three parameters, on a 'per message' basis:- - the average transit time expected. - the "maximum" transit time within which the majority (e.g. 95%) of messages must be transferred. - the cut-off time at which the application needs to take active recovery action (i.e. the message is no longer expected to transfer successfully). For CO transport, the 'per connection' transit time parameter on connection establishment can be derived from the "best" (lowest average) of the 'per message' times. This information may be used by network designers. Section 6 illustrates these times and their significance.
Residual Error Rate shall be specified as a design parameter, for each application. **All ATN applications will have the same value**	There are two services here:- The communications services can be required to provide any reasonable level of error protection. This can be implemented by a combination of upper and lower level services, and is

Statement in WG1 Report, Appendix d (Flimsy 3)	Comment on Requirement
	mathematically calculated. Applications will specify this. The ISO connection oriented transport service specification describes "Residual Error Rate" as an indication of the errors being detected in the transport machine which have got through the network error detection mechanism. This is not interesting to Applications, as long as throughput and transit delay requirements are met. It may be of interest to network designers and systems managers.
Service Loss Reporting shall be specified as a design parameter, for each application. **All ATN applications will have the same value.**	There are two distinct services here:- - A service is being provided, but a QoS requirement (e.g. transit time) is not being met (on a message by message basis). This can be monitored by application or upper layer functionality. - The service has failed, lower layer disconnect or abort indication, or has timed out. (no response to message by failure time)
Availability shall be specified as a design parameter, for each application.	This needs more precise definition. A proposal is:- "The probability that a communication path of required throughput and transit delay can be set up at any given time" It is by no means clear that an application can specify this. A figure may be determined through safety case studies.
Service Restoration Time shall be specified as a design parameter, for each application	Service restoration is the sum of:- - detection of service loss - connection establishment - re-establishment of application context

2.2 Message Sequencing

Sequentially ordered message delivery capability is required (e.g., where succeeding message delivery is dependent upon the successful delivery of preceding messages).	This is not a requirement for all applications, and is an unwelcome constraint for some (e.g. ADS reporting). However, ISO Transport Class 4 gives this service without option, and therefore it is a given for package 1. It should be recalled that there is no technical requirement for a connection oriented transport service for package 1. This was a policy decision based on certification issues, and is unrelated to technical requirements. In the meantime, WG3 have worked on the assumption of a connection-oriented transport service, and would now be unable to change direction whilst maintaining package 1 time scale targets.

Statement in WG1 Report, Appendix d (Flimsy 3)	Comment on Requirement
2.3 Communication Service Termination	
The communications service shall provide an orderly termination of service upon indication by the application (e.g. if messages have been passed to the communications service and then a termination of service is requested, the preceding messages are to be delivered as per normal operations before the service is terminated). It is noted that the ATN Upper Layer Architecture will provide this service	"indication" should read "request". Note also, the upper layer architecture is a specification framework. The upper layer SARPs will specify the service and how it is delivered
Upon failure of orderly termination an indication shall be provided to the application. It is noted that the ATN Upper Layer Architecture will provide this service	Upon failure of an orderly termination *request,* a service provider abort indication shall be provided to the application. Again, the upper layer architecture is a specification framework. The upper layer SARPs will specify the service and how it is delivered.
2.4 Priority	The "Priority" field in the lower layers is used to carry the ITU traffic type information, and is not available to use for the user perception of priority, (described as "urgency" in the ADS material) to signal relative importance of messages on a connection. (See section 4)
Applications shall use priority in a manner consistent with ICAO ANNEX 10 and ITU radio regulations.	OK - to be specified in SARPs (in case the implementor does not have a copy of ITU regulations to hand)
There shall be a one-to-one relationship between application specified priority and any communication service priorities (e.g. transport layer, network layer, etc.).	Not one-to-one. There has to be a *defined* relationship, in the *appropriate* SARPs. (It is **NOT** an implementors choice) There is a one-to-one relationship between application, transport and network priorities only.
Note that for the CNS/ATM-1 package, application specified priority will not necessarily invoke processing within the transport service entity (e.g. will not result in the reordering of transport entity queues), but will be used internally by the network layer to reorder transmission queues. Transport priority is only of significance between the end-users of the transport service; thus, there is no requirement in Package 1 that transport priority be used by the transport protocol layer for internal processing purposes or for internal resource allocation (connection and buffer management) purposes although this is not precluded	
2.5 Routing Policy	
-1 Applications shall be able to set routing policies based on a) QoS requests, and on b)	Network designers and /or managers set routing policy. For (a), this will be static rather than

Statement in WG1 Report, Appendix d (Flimsy 3)	Comment on Requirement
Traffic Type identification.	dynamic.
-2 QoS policies shall be applied on a “best effort” basis. In the terminology of the Working Group 2 experts, this means that “Weak QoS” is required. Traffic Type policies shall be applied on a “must be enforced” basis. In the terminology of the Working Group 2 experts, this means that “Strong Traffic Typing” is required.	
-3 Policy information must be indicated by the application to the communication service and will be conveyed on end-to-end basis in the CLNP NPDU header.	The term ‘end-to-end’ implies between the end systems. Policy information is only useful if intermediate systems pick it up and act on it.
-4 Airlines have a further requirement that, for any air/ground subnetwork that supports multiple simultaneous router-to-router connections (e.g. as is possible via the Satellite data link), a mechanism must be defined whereby the correct ground-based air/ground router is selected based on local aircraft policy decisions.	

2.5.1 QoS Policy

Applications shall be able to specify that message traffic be routed to achieve one of the following QoS policies: Minimal Transit Delay. Minimal Cost. No Policy on QoS (i.e. “don’t care”).	There is no requirement for this. The application specifies traffic type, throughput and transit delay. From these parameters the lower layers must determine the best cost route. The ATN internet is in any case not offering this for package 1.

2.5.2 Traffic Type Policy

Applications shall be able to specify that message traffic be routed to achieve one of the following Traffic Type policies: <<< See Source Document>>>>	This was first articulated at the Toulouse meetings, and came from an IATA requirement. It has to be recognised that to meet this requirement changes are needed in the lower layer draft SARPs.

2.6 Message Duplication

A message delivered to the communications service shall not be delivered more than once to its peer entity.	A message *submitted* to the communications service shall not be delivered more than once to the distant application This is correct as a requirement, but can be achieved either by the internet (Transport Class 4) or by the upper layers. For package 1, as Transport Class 4 is a ‘given’, and provides this service, there is no point in re-engineering this in the upper layers.

Statement in WG1 Report, Appendix d (Flimsy 3) | **Comment on Requirement**

2.7 QoS Monitoring

No QoS monitoring is required to be provided in the CNS/ATM-1 package. Inclusion of this capability in future CNS/ATM packages is not precluded.

There are two different services under this heading:-

- the service provided by the internet, whereby routers read the QoS parameters in the NPDU header, and make routing decisions accordingly. This is not required for package 1.

- the service by which the application or upper layers monitor the QoS (transit delay) being delivered by the lower layers, and warn the user of, or take action on exceptions.

3. COMMENTS ON IMPLICATIONS OF REQUIREMENTS

The comments on this section are handled as for section 2.

Statement in WG1/2 Appendix D | **Comment on Requirement**

3.1 General Design

The noted requirements regarding general network design pose no particular implications

3.2 Message Sequencing

Working Group 3 ad hoc discussions lead to the requirement of connection oriented transport only, in the CNS/ATM-1 package time frame. IATA requirements for per message policy enforcement require functionality best supported by a connectionless transport service.

The policy decision that the initial implementation of the ATN internet would be with the connection oriented transport service was made some years ago. The situation today is that, despite the technical attractiveness of connectionless transport as better meeting application requirements, it was too late to make such a significant change of direction.

3.3 Communication Service Termination

Orderly service termination is not provided by the transport layer. This function must be provided as part of the upper layer architecture or application design. There are no transport layer implications of this requirement in package 1.

3.4 Priority

Priority in the transport layer affects transport operations only. Network priority, while related to transport priority for consistency, only affects the operation of the network components (e.g., CLNP routers and end-systems). Further, network and transport priority are semantically independent.

One of the consequences of connection oriented transport.

Statement in WG1/2 Appendix D	Comment on Requirement
Package 1 intermediate systems will be required to forward data consistent with CLNP priority. Every NPDU associated with a given transport connection must have the same priority	

3.5 Routing Policy

Routing policy, as stated above, requires weak QoS and strong traffic type routing.

3.5.1 QoS Policy

End-to-end QoS decisions require that ground IDRP routers exchange route information including QoS. Thus, IDRP route information exchange including QoS poses certain risks to ongoing validation efforts given current validation and operational implementation schedules.

3.5.2 Traffic Type Policy

Statement in WG1/2 Appendix D	Comment on Requirement
End-to-end policy enforcement requires that all ground IDRP routers receive route information including traffic type, make routing decisions, and populate local FIBs accordingly. This requires that IDRP update PDUs contain traffic type route information. Without this traffic type information, there is no guarantee of end-to-end policy enforcement and ultimate air/ground subnetwork choice based upon stated traffic type. If suitable network design provisions are not available, then traffic typing must be conveyed in the CLNP NPDU and acted upon by every router in the communications path to facilitate end-to-end traffic selection and policy enforcement. To communicate traffic type on an end-to-end basis, ground IDRP decisions must be made on this information and knowledge of this information must be conveyed amongst IDRP ground routers. For this reason, guaranteed end-to-end policy decisions may not be feasible in the package 1 time frame.	Strong Traffic Policy enforcement is a requirement for package 1 (to meet ITU regulations). If this implication is that the requirement can not be met, then it may be necessary to prohibit use of the ATN by any but ICAO ATC applications. This would not be a good move for the future of the ATN. Also, the ATN is not likely to be attractive for AOC traffic unless the IATA Traffic Types policy requirements can be satisfied.

3.6 Message Duplication

Statement in WG1/2 Appendix D	Comment on Requirement
No implication exists given the use of ISO connection oriented transport protocol.	OK

3.7 QoS Monitoring

Statement in WG1/2 Appendix D	Comment on Requirement
QoS "rankings" are only known by the routers on an a priori basis in the CNS/ATM-1 package architecture.	This relates to one aspect of QoS monitoring, the implication of acting on QoS within a router. At a future stage, QoS monitoring could be used by a systems management function to set QoS rankings. Verification that the required QoS is being met, is

Statement in WG1/2 Appendix D	Comment on Requirement
	proposed for an upper layer or application service for package 2.

4. MAPPING OF PRIORITY AND TRAFFIC TYPE

The following figure illustrates the mapping between application concept of ITU Priority and IATA Traffic Types to the Transport and Network Service. The means by which this is achieved in an end system is a local matter.

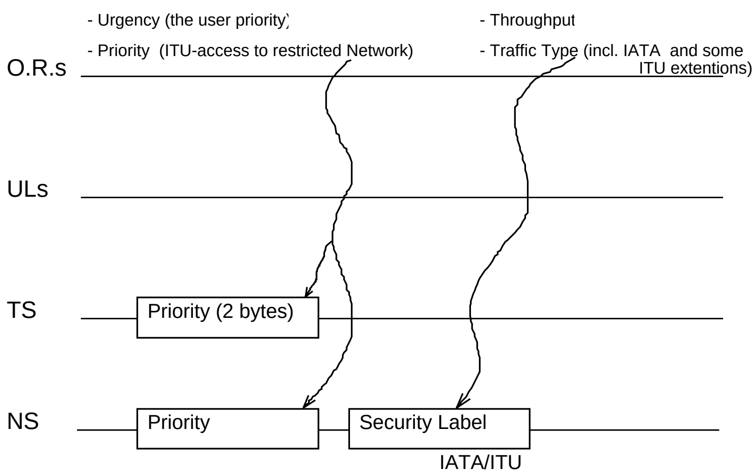

Figure 1 Mapping of “Priority” and Traffic Type

The figure above shows the current situation for mapping ITU ”Priority” level onto the Network Service Priority. It also shows proposals to map the IATA traffic type onto the Network Service Security Label. Because of the way the traffic type is defined, some of the ITU priority levels are reflected in the Traffic Type. In addition, some of the user priority definitions have the same name as ITU priority levels (distress, urgent, normal, low), but currently only influence the order of presentation of information after transmission, rather than an ordering for transmission.

5. PROPOSED DISTRIBUTION OF FUNCTIONALITY

The table below indicate who/where requirements should be specified, and who/where the requirements should be satisfied/implemented. It is divided into three phases, connection set-up, data transfer, and connection termination.

Requirement	Operational Reqs.	Application SARPs	Upper Layer SARPs	Internet SARPs	Internet Design
Connection Set-up: * **-**					
Required Throughput	S	P	P	P	I
Required Transit Delay (Average, Alarm level, Failure level)	S	P	P	I	I
"Priority" (ITU)	S	P	P	I	
Traffic type (Inc. some ITU priorities, and IATA policy)	S	P	P	I	
Residual Error Rate:- - Requested - reporting♣	S	P	P	I	
Connection Set-up Time	S	P	P	P	I
Availability	S	P	P	P	I
Data Transfer:-					
Message sequencing		P	P	I	
Transit Delay monitoring		S	I		
Service loss reporting		S	P	I	
- during traffic (Transfer Delay exceeded)		S	I		
- between traffic (Provider Abort)		S		I	
User Acknowledge	S	I			
Service restoration	S	I	I		
Connection Termination:					
Orderly Release	S	P	I		
Release internet		S	P	I	
Release Internet Time		S	P	I	
Provider Abort				I	

Legend: **S** Specifies
P Passes requirement through
I Implements (In SARPs, specifies how service is delivered)

6. FURTHER INFORMATION ON TRANSIT DELAY

In any situation where information (traffic) is flowing over a queuing medium which imparts delays (e.g. the ATN internet), the delay to which any individual message is subject is indeterminate. Two graphs illustrate the distribution of messages over time.

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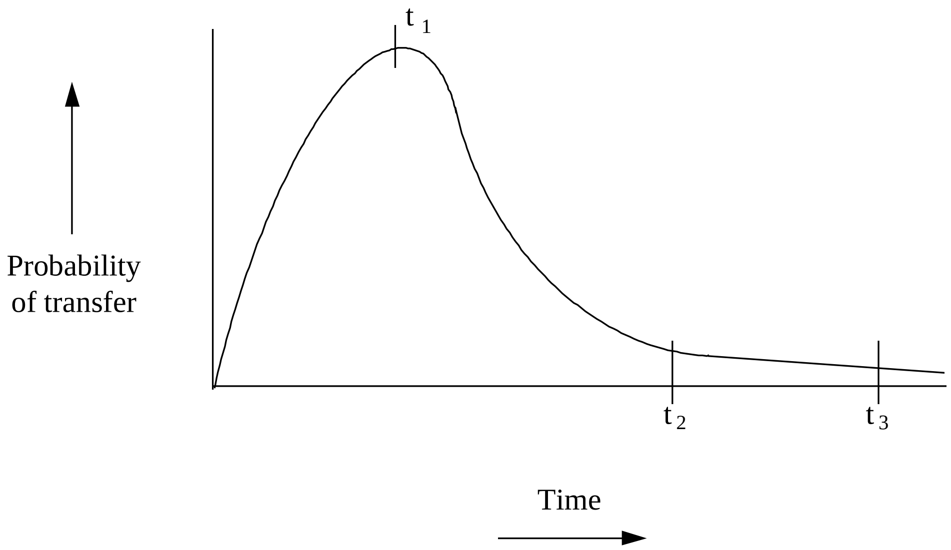
* On connectionless transport these parameters are seen in the data transfer phase, if appropriate.

♣ The exact semantics of this are for further study.



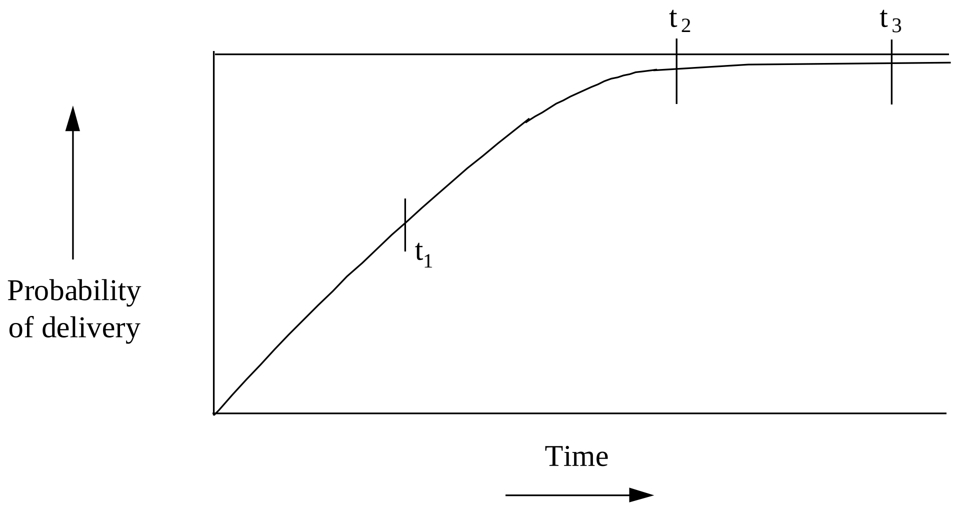
The curve above shows the probable delay to any one message. As can be seen, there is zero probability that the message gets through in zero time, rising to a peak which represents the average delay time. Thereafter, the curve descends but flattens out as it approaches the X axis (Zero probability), because some messages, at a low probability, can experience exceptionally long delays. In fact, for the ATN internet, the curve never reaches the X axis, because there is a finite (but very low) probability that a particular message will never get through.

For ATN applications, it is proposed that three times are associated with each message.

- t1 represents the “average” time delay that a message may experience
- t2 represents the time by which the message should have been successfully transferred, with ‘n%’, typically 95% probability
- t3 represents the time by which there is no further point in waiting for the transfer to take place. At this point, the application may reasonably assume that the communications path is no longer viable, and a new path should be established.

The time (t3) is therefore also the time at which a connection failure should be signalled, in the event that no traffic is flowing.

An alternative representation is shown in the following figure, which is the mathematical integral of the figure above (i.e. the area under the curve). This shows the probability that a message has been delivered by a certain time



This curve climbs from zero probability at zero time, towards a probability of 1 (100%) as time progresses. In doing so, it passes through t1, the average (50% point) and t2 which, for example, may be specified as 95%. T3 is the failure time, and may be set at 99.999%. The curve never reaches 100%, because there is always a small but finite probability that some a message never gets through.

The application has no interest in parameters such as "lowest cost" versus "shortest time". The communications service should be able to take the parameters above and decide, from its own knowledge of the communications paths and likely delays, how it can meet the requirements at lowest cost. ("Least Cost Routing").

This model is fine for connectionless transport, but for connection-oriented transport decisions on the worst case parameters during a connection need to be specified at connection set-up time, based on the application's knowledge of the purpose for which the connection is to be used. These values are used by network designers and the network itself to ensure that an appropriate quality of service is delivered.