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Validation of Congestion Management Proposal

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SUMMARY

This paper describes additional simulation exercises necessary in order to investigate any adverse interactions between the Transport Backoff algorithm proposed for ATN Congestion Management and ATN System Mobility. It also investigates a proposed mechanism for avoiding such problems.

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1. Introduction

1.1 Background

ATNP/WG2/WP140 was prepared as a Eurocontrol contribution and provides proposed draft SARPs in support of Congestion Management procedures in the ATN Transport Layer. It was presented to WG2 at its Rome Meeting. However, the proposal was not accepted due to objections from the FAA. These objections were based on reports that the Mobile IP specification being developed by the Internet Community had found problems in the "Back-off Algorithm" which was the substance of WP140. Eurocontrol took on an action to investigate these issues.

This investigation has now been completed (see ref 2 below), and concluded that most of the problems that affect Mobile IP are not relevant to the ATN and indeed, that an unmodified version of the back-off algorithm may be appropriate. These conclusions now need to be validated and, in particular, validation activities should:

i) Investigate whether, in a typical operational scenario, ATN performance is significantly affected by changes to a mobile's point of attachment (due to the application of the Back-off algorithm), and at what rate of change performance is affected.

ii) Investigate the impact of providing an indication to a sending End System (by way of a CLNP Error PDU) that a packet has been discarded due to a change in the point of attachment (indicated by error reason "destination unreachable"), and acting upon this indication to (a) forcing rapid recalculation of the round trip delay, and (b) overriding the back-off procedure.

1.2 Scope

This document provides the initial high level specification for such validation exercises. A more detailed specification will be prepared from this document.

1.3 References

1.	ATNP/WG2/WP140	Minimal solution for Congestion Management
2.	DED1/ATNIP/STA_ATNP /DCO/35	Analysis of the Mobile IP Proposal and Comparison with ATN Mobile Routing

2. Investigation of the Impact on the Back-off Algorithm of changes to a Mobile System's Point of Attachment

2.1 Aims and Objectives

The primary objective is to demonstrate that at the anticipated rate of change between mobile subnetwork points of attachment, the false invocation of the back-off algorithm has the expected negligible impact on throughput. This needs to be investigated both for data streaming applications and request/response style applications that use the connection mode transport service.

The secondary objective is to determine at what rate of change between mobile subnetwork points of attachment is there an impact on throughput.

2.2 Configuration of the Simulation Model

The configuration required is illustrated in Figure 1. This illustrates a single fixed End System communicating with a single mobile End System. The End Systems communicate over the simulated ATN Internet using the COTP implementing the back-off algorithm specified in [1].

Three routers form the simulated ATN Internet. Routers 1 and 2 support simulated mobile subnetworks and the mobile End System may attach to either of these. At any one time, the mobile End System may be reachable through either or both mobile subnetwork, although only one provides the selected route to it. The simulated mobile subnetworks must simulate the transit delay characteristics of mobile subnetworks (e.g. Mode S), and should have different transit delay values in order to test the impact of changes in round trip delay.

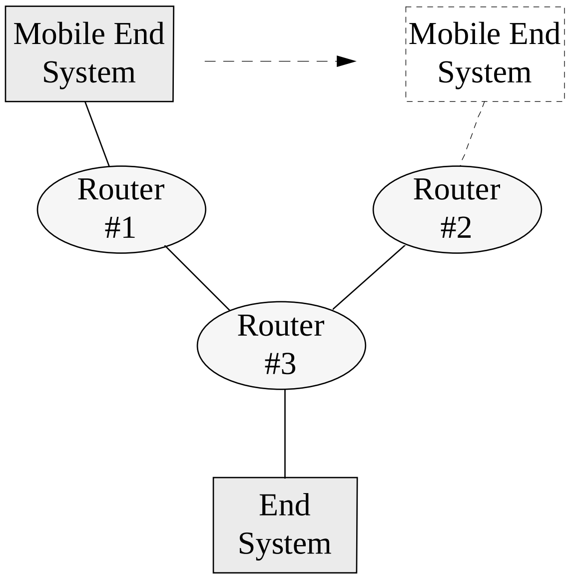

Figure 1 Configuration for First Simulation Exercise

The Mobile End System will also need to be configurable with respect to the time between receipt of a DT TPDU and the return of an AK TPDU. This parameter is very significant in respect of how quickly the ground End System determines that packets have been lost as a result of a change in the point of attachment, and hence how quickly recovery action is effected. The simulation will need to be run with different values of this parameter.

The simulation starts with the Mobile End System reachable through Router #1 and its mobile subnetwork. After a specified period, the Mobile End System changes to using Router #2 and its Mobile Subnetwork; any packets in transit through Router #1 and queued for transmission over the mobile subnetwork are discarded.

After the same period, the Mobile End System changes back to using Router #1 and, similarly, any packets in transit through Router #2 and queued for transmission over the mobile subnetwork are discarded. This switching back and forth is repeated for the duration of the simulation.

The period between the Mobile End System changing routers is the key parameter of the simulation. The simulation is first run with this period set to 30 minutes, which is believed typical for a non-satellite mobile subnetwork. Further simulations are then run, with this period progressively reduced to one minute. Each simulation will need to be run for a period of time necessary to observe the impact on performance of the changes in mobile End System point of attachment (probably of the order of 3 hours, but this may be reduced for smaller periods).

Two application classes need to be simulated: data streaming and request/response. Both should be users of the connection mode transport service. The data streaming application should aim to send a continuous data stream from ground to air. The transfer rate should be measured and recorded, both as an overall figure and as measured at regular intervals. The request/response application should issue a “request” on a periodic basis (e.g. 30 seconds), which generates a “response” from the other End System. The time between sending each request and receiving the corresponding respond should be recorded, and a mean response delay calculated.

The simulation will need to be calibrated by running the simulation without changes in the mobile End System’s point of attachment (i.e. with the period between changes set to infinity). This will enable the throughput and response time to be determined without the perturbation introduced by changing points of attachment.

There is no requirement to simulate congestion in the ATN Internet, as it is the impact of false indications of congestion that is being investigated, rather than congestion itself.

2.3 Interpretation of Results

Of interest is the impact of both throughput and response time of a change in a mobile End System’s point of attachment, and for how long the effect is noticeable. For each simulation, an overall impact should be calculated as a percentage of what is achievable with changing the point of attachment. The duration of reduced performance should also be presented, and the worse case loss of performance (measured on an instantaneous basis) presented.

A 5% drop off of overall performance is viewed as acceptable, and the simulation result should determine when this occurs, in terms of the period between successive changes of the point of attachment.

The impact of changes to the AK TPDU timer will also be of interest. The above results need to be prepared for a range of such timer values, probably specified in multiples of the typical mobile subnetwork transit delay.

3. Investigation of the Benefits of Feedback when a Mobile System changes its Point of Attachment

3.1 Aims and Objectives

When a packet is discarded due a mobile system having changed its point of attachment, an Error PDU may be returned with a reason indicating that the destination is unreachable.

This may be taken by the sender to imply that the destination mobile system has changed its point of attachment and then to:

a) Perform a rapid recalculation of the round trip delay (e.g. by re-initialising the round trip calculation algorithm)

b) Suppress operation of the Back-off algorithm for a defined period of time[1]

The simulations presented above in section 2 may then be re-run with modified End Systems to determine whether a performance improvement is noticeable and useful. The modified End Systems should always request that an Error PDU is returned if a CLNP packet is discarded, and have their back-off procedures modified as described above.

3.2 Configuration of the Simulation Model

The configuration is identical to Figure 1, except that the modified End Systems are used. The simulations are then repeated. Several simulation runs will be needed with different values of the period for which the back-off algorithm is suppressed. This period will be of the order of the lifetime of a packet.

3.3 Interpretation of Results

The results are compared with the first simulation to see what improvement, if any, is achieved as a result of these modifications. If a significant improvement (e.g. better than 5%) is achieved for a period between changes to the point of attachment, that is not atypical for the ATN, then a recommendation to include such modified procedures in ATN End Systems should follow.

[1] Note that to avoid undesirable interactions should the ATN be congested when such an Error PDU is received, real implementations will need to invoke the back-off algorithm normally, if Error PDU are also being received that indicate packet discard due to congestion.