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ATN Application Level Systems Management Utilities

Prepared by: Tony Kerr

Presented by: Tony Kerr

SUMMARY

This paper proposes some simple ATN Systems Management tools based on GACS. The tools would, if implemented, support requirements for measuring various end-to-end Quality Of Service (QoS) parameters available to ATN applications, as well as providing a simple diagnostic test of reachability at the application service level.

The Working Group is invited to study the proposed functionality and to form an opinion as to whether such functions should be incorporated in a future revision of the ATN Technical Provisions.

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1. INTRODUCTION

This document contains initial proposals for an end-to-end test tool based on a Generic ATN Communications Service Application Entity (GACS-AE).

A standardised application level SM tool could be an invaluable aid to real-time operational fault diagnosis and performance evaluation of the ATN as a whole. If implemented on all ATN end systems, the tool outlined in this paper would provide an authorised user (e.g. the Systems Manager) with a simple consistent means to perform the following functions:

a) to determine the reachability of a given remote end system (application level “ping” function);

b) to provide a simple health check of the end-to-end path between two systems;

c) to measure round-trip delay, as a function of ATSC class and priority;

d) with time synchronisation, to measure the transit delay, as a function of ATSC class and priority;

e) to measure connection set-up time for application associations;

f) over time, to build up statistics enabling the general performance metrics required by the ADSP Manual to be monitored;

g) to verify data integrity across the ATN;

h) to execute simple management commands on a remote end system.

The outline functionality of such a tool is outlined here.

Since the GACS service provides ATN applications with all of the communications capabilities they require, it should be relatively easy to construct a simple Responder application on top of GACS, and this could form the basis of a globally useful ATN confidence test / system management utility.

1.1 References

[1] Manual of Technical Provisions for the Aeronautical Telecommunication Network (ATN) - ICAO Doc. 9705-AN/956 First edition – 1998

[2] Draft Technical Provisions for Generic ATN Communication Service (GACS)

[3] Draft Revision to ULCS Technical Provisions for ATNP/3 – ATNP/WG3/WP 16-10 (12 May 1999)

[4] Potential future Operational Requirements for the Generic ATN Service – GACS – ATNP/WG3/IP 16-01 (11 May 1999)

[5] Fault Management Requirements Analysis, Eurocontrol ATN Project DED6/ATNCT/SYSMAN/DCI/L721v1.1 (March 1999)

[6] Performance Management Requirements Analysis, Eurocontrol ATN Project DED6/ATNCT/SYSMAN/DCI/L720v1.2 (March 1999)

2. SYSTEMS MANAGEMENT REQUIREMENTS TO BE SATISFIED

Monitoring the end-to-end performance of the ATN service provided to application users is a stated requirement in the ICAO ADSP manual (ICAO Doc. 9694). The objective is to enable evaluation of the operational effectiveness of the communication resources by means of statistical information and logs of system state histories.

The ADSP Manual defines, in Part I, Chapter 3 Appendix A, three types of communication systems performance requirements related to the ATS data link applications:

- General Performance Requirements
- Application Specific Performance Requirements
- Transfer Delay Requirements

These are considered in turn in the following subsections.

Also, an analysis of the fundamental requirements for ATN Fault and Performance management has been carried out in [5] and [6], and the relevant requirements from these documents are reproduced in the following subsections.

2.1 General Performance Requirements

To ensure that the general performance requirements on the air-ground applications are being met, it is necessary to measure:

a) the probability of non-receipt of a message,

b) the probability that non-receipt of a message will fail to be notified to the originator, and

c) the probability that a message will be misdirected.

The performance requirements in terms of message non-delivery can be designed into a system, and bench-tested before operational use. However, there is still a need to monitor whether the requirements are being met during operational use. (Objective 14 in [6]).

2.2 Application Specific Performance Requirements

The performance requirements specific to each air-ground application are defined in the ADSP Manual, in terms of Availability, Integrity, Reliability and Continuity figures for each application.

It is necessary to make assumptions as to what period of time these statistical figures are to be measured over. For example, if averaged over a week then the achieved performance in one particular minute could have been well outside of these requirements.

Again, there is a need to monitor whether these requirements are being met during operational use of the ATN applications. Clearly, part of the performance is related to the specific application subsystems, but a large part is related to the usage by the applications of the ATN infrastructure, in terms of requested QoS parameters, and this can be simulated by a general purpose systems management tool.

2.3 Transfer Delay Requirements

The performance requirements assumed to be available to each air-ground application are defined in the ADSP Manual, for each ATSC class, in terms of the Mean, 95% and 99.996% End-To-End Transfer Delay, measured in seconds.

These transfer delay figures are intended to represent the total transfer time from human user input at one side to human user perception at the other end.

The requested ATSC class (A through H) can be selected by the application user on dialogue initiation, and is not known in advance by the application ASE implementation. As the actual transit delay is indirectly dependent on the requested class of communication service, this parameter should be made available with the transit delay measurements. (Objective 15 in [6])

2.4 Requirements Related to Fault Management

Ref. [5] identifies a number of requirements, which can be satisfied at least in part by the tool proposed here.

([5] Section 4.2.3): Transport level faults require diagnosis techniques additional to those required for Routers and Subnetworks. A Test Application will be needed to diagnose suspected transport service problems. Such a Test Application will need to be able to test and verify all transport service functions and to act as test data generator and data “reflector” in order to test for data integrity problems. The typical scenario for such a Test Application is with the End System isolated from the network. However, there may be circumstances when it needs to be tested online.

(REQ 3 in [5]): Applications that implement compliancy checks on the operation of the Transport Service are required to notify a Network Manager of incorrect operation of the Transport Service.

(Failure Mode #17 in [5]): Failure to Report an Unacceptable Quality of Service Degradation

This failure mode will result from errors in the measurement of round trip delay by the sending transport protocol, or is due to a failure to detect/report non-receipt of an expected AK TPDU. The former case could also result in spurious reports of QoS degradation, when the transport service is in fact behaving within normal operating parameters. Such a failure mode can only be detected by the application maintaining its own checks on round trip delay and “liveness” of the transport connection.

This is not an internet error but a software error in the End System, and it is not useful to report such a problem to a Network Manager (via CMIP notification). However, such problems should be logged locally, if detected by an application, as well as reported to the End User if there are implications for the correct operation of the application.

2.5 Requirements Related to Performance Management

Ref. [6] identifies a number of requirements, which can be satisfied at least in part by the tool proposed here.

(REQ 17 in [6]): The Dialogue Service is required to record, in a local log, each connect request, and the time at which the connect request was issued.

(REQ 19 in [6]): The Dialogue Service is required to record, in a local log, the time of each successful connection establishment.

(REQ 22 in [6]): The mean transit delay of packets through an End System shall be measured under various loading conditions.

(REQ 58 in [6]): An event shall be logged whenever a user message crosses the notional ASE service boundary.

(REQ 60 in [6]): Use should be made of application time-stamps, where available, to estimate the end to end transfer delays of user messages.

(REQ 61 in [6]): For each confirmed application service, the round trip delay between request and confirmation messages shall be logged.

(REQ 62 in [6]): A tool is required to analyse logs of user message transfer times vs. requested ATSC class. Over a given period, the mean, 95% and 99.996% end to end transfer delays should be computed for received user messages for each ATSC class.

3. SYSTEMS MANAGEMENT UTILITIES USING GACS

3.1 Functional Requirements

Two basic functions are defined for a SM application tool to satisfy the above requirements:

- Simple confidence test and round trip time measurement;
- Automatic response supporting data integrity check and measurement of transit delay and application association establishment delay.

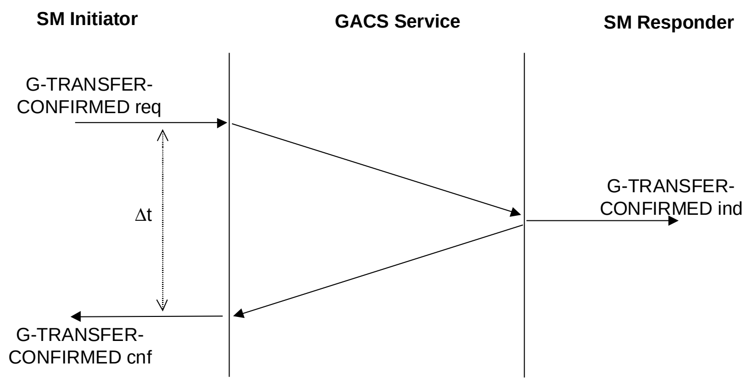

Figure 1. Simple confidence test and round trip measurement

These are illustrated in Figures 1 and 2, respectively, assuming a SM tool based on the GACS service definition. GACS is a suitable basis for such as tool, as it provides much of the required functionality in terms of services defined, message demarcation and parameter selection.

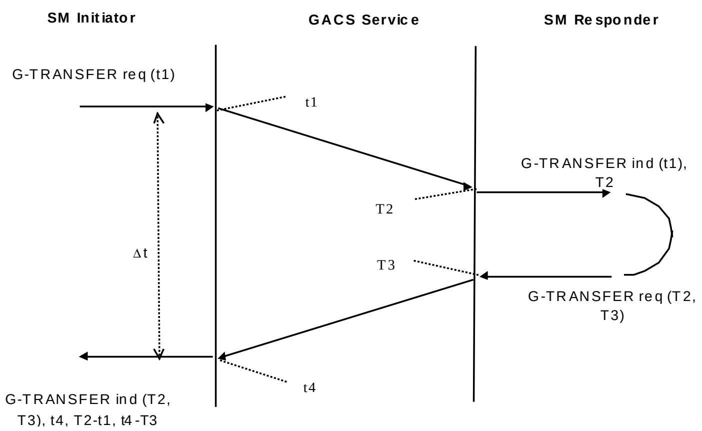

Figure 2. Automatic response supporting data integrity check and transit delay monitoring

The proposed systems management support tool shall be implemented using the GACS-AE. It shall comprise two distinct functional elements, the initiator and responder elements, as illustrated in Figure 3.

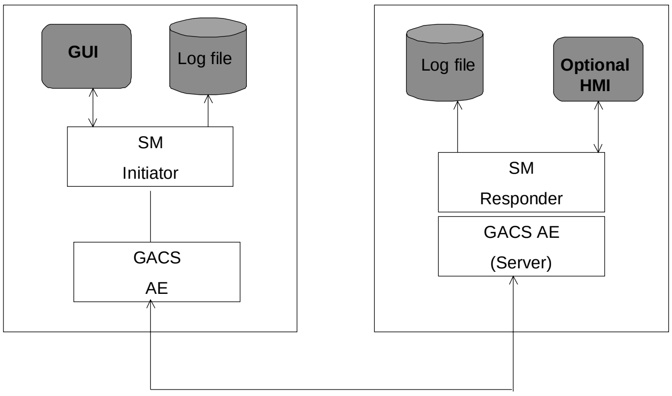

Figure 3. SM Initiator and Responder functions.

3.1.1 SM Initiator functional outline

1) The application user shall be provided with the ability to initiate a G-TRANSFER-CONFIRMED message to a specified recipient, with user-defined QoS parameters, a message type of "systems management," and no User Data.

When the confirmation message is received, or a timeout occurs, the result shall be displayed to the application user. The information displayed and logged shall include the requested ATSC (or AOC, etc.) class and priority and the elapsed time between the submission of the GACS request to the GACS ASE and reception of confirmation by the GACS ASE. The mode of dialogue service actually used shall be displayed (CODS or CLDS).

2) The application user shall be provided with the ability to initiate a G-TRANSFER message to a specified recipient, with user-defined QoS parameters and a message type of "systems management". The User Data shall contain a timestamp. Optionally, the user can specify a simple command and either attach file or input a text message, which is then included in the User Data. Initial commands could include:

ECHO: request that the included data be reflected back in the reply message.

TYPE: request that the included data be displayed on the remote HMI, if possible.

GET CONFIG: request for configuration information pertaining the applications on the remote system.

PUT CONFIG: request to update the configuration file at the remote system.

When a reply message is received, or a timeout occurs, the result shall be displayed to the application user. The information displayed and logged shall include the ATSC (or AOC, etc.) class and priority, the timestamp information from the User Data, and the elapsed time between the submission of the GACS request to the GACS ASE and reception of the reply by the GACS ASE. The mode of dialogue service actually used shall be displayed (CODS or CLDS). If the initiating user requested that User Data be reflected back in the reply message, the SM Initiator shall compare the received User Data with the sent data, and signal the result to the user.

3) The SM Initiator shall have the ability to automatically perform functions 1) and 2) at pre-defined intervals with a configurable list of recipients, and log all responses, correlated with requests. The HMI shall allow graphical presentation of round trip times and transit delays per ATSC class and priority.

4) By allowing the initiator to select the value of the Requested Level of Service at the GACS service boundary, measurements can be performed for Connectionless (CL) and Connection-oriented (CO) configurations. In the CO case, connection establishment delay can be deduced by obtaining comparative measurements of round trip delays in “multi-shot” and “single shot” modes.

3.1.2 SM Responder functional outline

1) The SM responder shall continually wait for incoming messages with a message type of “systems management”.

2) When a G-TRANSFER-CONFIRMED indication is received with no User Data, the event shall be read and logged locally. The confirmation should be generated by the GACS-ASE as soon as practicable after the indication event occurs. (This implies that the GACS Client and Server should be co-located, to avoid IPC queue delays).

3) When a G-TRANSFER indication is received with User Data, the SM Responder shall display any associated text message or capture any attached file. It shall log/display the event together with current local time and the timestamp contained in the User Data. It shall automatically send a reply to the initiator using G-TRANSFER, with User Data containing the original timestamp, the local time at which the message was received by GACS-ASE, and the time at which the reply was submitted to GACS-ASE. The SM Responder shall implement a simple command interpreter. If the initiator issued an ECHO command, then the received User Data shall be copied to the reply. Other commands are for further study.

4) The Responder shall be capable of starting automatically when the GACS-Server is started, with no need for manual intervention.

3.2 Suggested Approach

a) It is suggested that an initial scoping exercise and production of detailed Functional Specifications for the SM Initiator and Responder functions be undertaken.

b) The next stage could be to produce a prototype implementation, based on the existing GACS-AE software, and to perform trials to obtain pseudo-operational experience of the systems management capabilities of the tool. Possible extensions to the command syntax would be proposed at this stage.

c) Based on the initial results, the tool could then be re-engineered using the GACS-ASO approach to produce a dedicated systems management support application.

d) Access control mechanisms would need to be added to prevent unauthorised users from obtaining sensitive addressing information or swamping the ATN with spurious high priority application messages.

4. CONCLUSIONS AND RECOMMENDED ACTIONS

The support application proposed in this paper allows a number of required ATN performance parameters to be measured in a straightforward manner, with little overhead in terms of software development or additional specification.

If the SM Responder function proposed here were provided on all ATN end systems, with appropriate security controls, then human or automated systems managers would have a powerful tool for application level fault and performance investigations across the entire ATN.

The Working Group is invited to study the proposed functionality and to form an opinion as to whether such functions should be incorporated in a future revision of the ATN Technical Provisions.