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Performance Management Requirements for the ATN Internet Communications Service

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SUMMARY

This document attempts to identify requirements for performance management of the ATN. The objective of this document is to provide a basis for the identification or the justification of the Managed Object attributes that will be part of the ATN Management Information Base.

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1. Introduction

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2. About Performance Management

ISO/CCITT defines performance management as follows:

Performance management enables the behaviour of resources in the OSIE and the effectiveness of communication activities to be evaluated. Performance management includes functions to

1. *gather statistical information;*
2. *maintain and examine logs of system state histories;*
3. *determine system performance under natural and artificial condition; and*
4. *alter system modes of operation for the purpose of conducting performance management activities.*

3. Requirements for performance management

3.1 Introduction

The ATN will be built on the basis of interconnection and Service Level Agreements of the ATN network of different administrations and organisations. Service Level Agreements are a written contract setting out in quantified terms the obligations of the provider and user of a communication service. They must be realistic so that they meet the business need, are achievable, measurable and verifiable. They are the basis for a Partnership and impose limits on the user as well as targets for the service provider.

Service Level Agreements are usually implemented where the service level is mission-critical (this is the case of the ATN) or where previous problems have led to more formal control. In either case, the implementation of agreements is a major exercise and is only practicable with the right tools.

Delivering a quality service, assessing acceptable levels of risk, running a cost-conscious operation, planning the future required capacity are the day to day issues facing the communication service provision department. To be successful, Communication Managers must be able to understand thoroughly what is happening in the managed network, know exactly why they are happening and anticipate the effect of what may happen in the future.

They need to be able to measure, analyse and predict, with complete confidence.

Performance Management embraces these activities such as system measurement, monitoring, analysis, resource accounting, tuning and optimisation. It is a continuing process in any well run communication centre. The alternative is the problem of trying to resolve performance panics.

The ATN will only fulfil its operational objectives if every organisation participating in the global infrastructure of the ATN is able to provide and demonstrate the required level of service.

Performance management is therefore a requirement for the ATN. Every organisation participating in the global ATN infrastructure should be in a position to insure and demonstrate a level of service meeting the operational requirements.

The solution lies in the extraction or the automatic collection of standard set of performance data and the manipulation of these data. The difficulty is then the definition of this standard set of data or functions.

The sections below attempt to identify a common standard set of low level requirements for performance management.

3.2 General

Performance management of the ATN is to be considered at different levels:

1. At the level of the whole portion of the ATN network which is managed. At this level, the system manager will be particularly interested by

    - the Management of the global Performance of the routing in the managed portion of the ATN

    - the Management of the global Performance of the internetwork communication service in the managed portion of the ATN

2. At the level of each individual system (BIS or ES), the system manager will be interested by

    - the Management of the Performance of the network layer protocol entities

    - the management of the performance of the subnetwork service as perceived by the managed system

    - the Management of the Performance of the transport protocol entities

The performance management of the subnetworks (e.g. performance of an X.25 WAN) is considered to be out of the scope of the ATN system management.

3.3 Management of the global Performance of the routing

The objective is to evaluate the routing effectiveness, i.e.:

- the correctness of the routing decisions, and

- the swiftness of the routing decisions,

- with consideration to the volume of the routing traffic.

With regard to the correctness of the routing decisions, the basic capability, that seems to be required for the manager, is to see which routes have been selected by a router for each particular destination. The following requirement is therefore identified:

REQ1	the system manager shall be able to retrieve the current route(s) selected by a router to a given destination.

The satisfaction of this requirement will allow the system manager to verify that a routing decision is compliant with what is expected with regard to the topology and the current status of the network. However, this requirement assumes that the system manager a priori knows all destinations currently reachable in the network. The following additional requirement is therefore identified:

REQ2	the system manager shall be able to retrieve the list of all destinations for which a router knows a route.

As a complementary mechanism, the system manager could take advantage of the record route function which will be implemented in all ATN routers; associated with the echo request/response function, this function will allow the system manager to interrogate the network about the selected path from a given source system to a given destination system. The following requirement is therefore identified:

REQ3	the system manager shall be able to trigger the CLNP Echo Request function with the record route option set and to receive an Echo Response notification including the recorded list of the Network Entity Titles of the routers that have forwarded the packed.

The swiftness of the routing decision, when considered in the context of the managed portion of the ATN, corresponds to the swiftness of the routing convergence. Convergence is the process of agreement, by all routers, on optimal routes. The values of interest for the manager, are the delay between the time where a route either go down or become available, and the time where all routers have eventually agree to a stable routing decision concerning this route.

No simple network management mechanisms seem to be available to get this value. A first solution is the off-line correlation and analysis of the time-stamped routing event traces that could be produced by each router.

For the on-line computation of the swiftness of the routing decision, it is not conceivable to require that routers report every changes in the routing table: this would create a huge volume of system management traffic, and this would require the availability of a complex system management application, capable of performing the on-line correlation and analysis of all received routing events. The solution would be the capability of the system manager, to request from the managed BISs the reporting of routing events corresponding to **one** particular route; associated with the capability to inject a dummy route in the routing table of a given router, this would allow the manager to perform on-line testing of the routing and to get indication on the swiftness of the routing decision.

The following requirements are therefore proposed to be identified:

REQ4	the system manager shall have the capability to inject a route in the network at any particular managed BIS
REQ5	the system manager shall have the capability to request from the managed BIS the report of all routing events related to a particular destination
REQ6	The system manager should have the capability to request/stop the logging/tracing of all routing events processed by a managed BIS

The performance of the routing is of interest to analyse function of the amount of routing traffic which is processed in the network. With different routing performance figures for different amount of routing traffic, the system manager may have the capability to extrapolate the results and plan the proper adaptation for the support of an increasing traffic.

The amount of routing traffic corresponds to the amount of routing update PDUs which are exchanged on the network and is a function of:

- the number of individual routes disseminated in the network
- the update rates of these individual routes

When considered in the scope of the management of a whole portion of the ATN, the number of individual routes currently processed could be seen equal to the number of routes to destination external to the managed domain plus the number of routes to destination internal to the domain. The sum of the update rates of each of these internal and external routes could then be seen as a value representing the amount of traffic supported by the managed portion of the ATN.

However the computation of such a generalised value for a whole managed portion of the ATN would be impractical. This is because; the managed domain is unlikely to be homogeneous in the density of the routing traffic: it may consist of end routing domains, transit routing domains, backbone domains, where the routers process a given (not necessarily distinct) subset of the total routing information processed in the managed domain. It is therefore considered that the manager of a domain will better and simpler get a picture of the routing traffic in the managed domain by observing this traffic at some particular key nodes of the managed network.

The requirement to get quantitative figures of the amount of routing traffic will therefore be expressed at the level of the management of the individual performance of the routers. This is covered in section 3.5 below.

3.4 Management of the global Performance of the internetwork communication service

Performance of an internetwork communication service can be characterised by a number of parameters such as:

- the volume of data traffic (e.g. number of processed data packets)
- the error rates (e.g. number of packets lost)
- the Quality of Service (e.g. observed transit delay)

In the same way as for the assessment of the routing traffic, the computation of generalised parameter values of the internetwork communication service performance is impractical for a whole managed portion of the ATN. This is because the parameter values (e.g. volume of data traffic, available throughput) are unlikely to be homogeneous in the managed network: as an example, the managed network may consist of high speed information highways, interconnecting medium or low speed roads which may have different performance characteristics..

It is therefore considered that the manager of a domain will better and simpler get a picture of the internetwork service performance in the managed domain by observing the performance at some particular key nodes of the managed network.

The requirement to get quantitative figures of the performance of the internetwork service will therefore be expressed at the individual level of the management of the performance of the routers. This is covered in section 3.5 below.

There is one exception however with respect to the assessment of the transit delays. Transit delays values cannot simply be monitored at the level of the routers. The solution lies in the use of the Echo request/response function which allows to measure the round trip time spent by one data packet between one source system and one destination system. With regular use of the Echo request/response function between different points of the network, the system manager can gather statistical data on the transit delay experienced in the managed network. The following requirement is therefore identified:

REQ7	the system manager shall be able to trigger the CLNP Echo Request function in the managed ES and IS and to receive the Echo Response notification

3.5 Management of the individual performance of an ATN system

3.5.1 IDRP

The objective is to evaluate the effectiveness of the IDRP entity of a given managed BIS. The performance of an IDRP entity should be managed in the following 2 distinct areas:

- the effectiveness of an IDRP entity in the establishment and maintenance of BIS-BIS connections.
- the effectiveness of the processing and exchange of the routing information

As concerns the effectiveness of an IDRP entity in the establishment and maintenance of BIS-BIS connections, a first requirement of the system manager will be to know in real time, which air/ground or ground/ground IDRP connections are currently established. For this purpose, the managed BISs must report every IDRP connection establishment and clearing. In addition to the dynamic notification of the adjacencies of a managed BIS, the manager will also need to get the information on its own initiative with the capability to get the list of all BISs currently adjacent to a managed BIS. The following requirements are therefore identified:

REQ8	the managed BISs shall notify every air/Ground and ground/ground IDRP connection establishment and clearing.
REQ9	The manager shall be able to get the list and the main characteristics of the adjacent BISs of a managed BIS

The objective is then to control the capability of the IDRP entity to recover from loss/corruption of BISPDUs and to keep the connections alive. The maintenance of BIS-BIS connection may require a fine tuning of the IDRP protocol parameter. The processing load of a router may prevent a quick acknowledgement of the received BISPDU, which may lead to unnecessary retransmission if retransmission timers are too short. On the other hand, long retransmission timers, may delay the dissemination time of a route in the case where the BISPDU conveying this route is lost or corrupted. The following requirement is therefore identified:

REQ10	the system manager shall be able to monitor the number of retransmission occurring on each BIS-BIS connection.

With regard to the processing and exchange of the routing information, the objective is to control the capability of a router to receive, process and disseminate the routing information. The manager will first be interested in the amount of traffic to be processed by the routers. The parameters to be monitored are:

- The number of routes stored in the RIBs
- The incoming routes update rate (on each BIS-BIS connection and the cumulative total) - current and maximum
- The outgoing routes update rate (on each BIS-BIS connection and the cumulative total) - current and maximum
- The Local RIB routes update rate - current and maximum

Additionally, the manager will be interested in the volume of data that this routing traffic represents. The associated parameters are:

- The number of octets of BISPDUs received since the beginning of the connection (on each BIS-BIS connection and the cumulative total)
- The number of octets BISPDUs sent since the beginning of the connection (on each BIS-BIS connection and the cumulative total)

This can be summarised by the following requirements:

REQ11	the system manager shall be able to monitor the amount of routing information stored in the RIBs of a BIS
REQ12	the system manager shall be able to monitor the update rate of the routing information
REQ13	the system manager shall be able to monitor the volume of data represented by the exchange of IDRP BISPDUs between BISs.

IDRP implements a credit-based flow control mechanism which allows the receiver to block the advertisement of BISPDUs from the adjacent BIS when it is not in a position to process all the incoming routing traffic. The cases where a BIS sets its credit to 0 are critical, since they stop the dissemination of the routing information. The parameters to be monitored are:

- The current and maximum number of outstanding BISPDUs blocked for advertisement due to a lack of credit (for each BIS-BIS connection)
- The current and maximum waiting delays of outstanding BISPDUs

The following requirement is therefore identified.

REQ14	the system manager shall be able to monitor the size and the waiting delays of the queue of outstanding BISPDUs blocked for advertisement to adjacent BISs

3.5.2 CLNP

The performance of the CLNP entity is simply characterised by:

- the amount of traffic received
- the amount of traffic sent/forwarded
- the amount of traffic discarded

In addition to simple statistics on the amount of CLNP traffic processed by routers and ESs, the monitoring of the CLNP entity may allow the system manager to get interesting statistics on the traffic types that are processed by the systems. The system manager will notably be interested by:

- the proportion of Error PDUs in the processed traffic
- the proportion of AOC, ATSC, System Management, Administrative and General communication traffic

The following requirements are therefore identified.

REQ15	the system manager shall be able to monitor the amount of traffic received, sent/ forwarded and discarded by ATN ESs or ISs.
REQ16	the system manager shall be able to get statistics on the ratio of Error NPDUs in the processed ATN internetwork traffic
REQ17	the system manager shall be able to get statistics on the ratio of each different traffic categories, in the processed ATN internetwork traffic

3.5.3 SNDCFs and subnetwork service

3.5.3.1 standard ISO8208 SNDCF and subnetwork service

A standard ISO 8208 SNDCF performs well if it succeeds in transmitting the SNSDUs toward the destination DTE. The X.25 subnetwork service performs well when Virtual Circuits are successfully established on demand and remain open for the successful transmission of data packet while they are needed.

In order to verify the good performance of a standard ISO8208 SNDCF and of the subnetwork service, the system manager will be interested by getting statistics on the number of errors encountered

REQ18	the system manager should be able to get statistics on the following standard ISO8208 SNDCF or subnetwork errors: • SNSDU discarded due to congestion/unavailability of the Virtual Circuit • call establishment failure • abnormal VC clearing • VC reset

3.5.3.2 mobile ISO8208 SNDCF and mobile subnetwork service

The requirement on the collection of statistics on errors in the case of the standard ISO 8208 SNDCF and subnetwork exists in the same way in the case of mobile SNDCFs and subnetworks. However, in the case of the mobile SNDCF, some additional error cases have to be entered in the accounts :

REQ19	the system manager should be able to get statistics on the following mobile ISO8208 SNDCF or subnetwork errors: • SNSDU discarded due to congestion/unavailability of the Virtual Circuit • call establishment failure • abnormal VC clearing • VC reset • receipt/generation of SNDCF Error Report • Deflate decompression error

Additionally, for a correct tuning of the mobile SNDCF protocol parameters, the system manager needs to have indication on the activity of the mobile SNDCF, and notably the number of mobile VCs concurrently established and the number of Local References used on the mobile connections.

REQ20	the system manager shall be able to get the current and maximum number of mobile VCs concurrently established
REQ21	the system manager shall be able to get the average and the maximum of the maximum number of Local References concurrently used (i.e. higher water mark) on the mobile connections

3.5.4 ES-IS and IS-SME

One of the main requirement of the system manager in the performance of a ground ATN managed domain will be to know how much and which aircraft are or have been in direct contact with the managed A/G BISs.

A first requirement of the system manager will be to know in real time, which aircraft is currently in contact with the managed A/G BISs. For this purpose, the managed BISs must report every air/Ground routing initiation and termination. In addition to the dynamic notification of the join and leave events, the manager will also need to get the information on its own initiative, with the capability to get the list of all aircraft currently in contact with a managed BIS. In the population of connected aircraft, the system manager should also know the proportion of IDRP-equipped and IDRP-not-equipped aircraft. Eventually, the manager should be able to get historical statistics on the maximum number of aircraft having been concurrently in contact with the managed BIS.

The following requirements are therefore identified:

REQ22	the managed BISs shall notify every air/Ground routing initiation and termination

REQ23	The manager shall be able to get the list and characteristics of airborne BISs currently in contact with a managed BIS.
REQ24	the system manager shall be able to get statistics on the maximum number of airborne BIS having been concurrently in contact with a managed BIS and on the proportion IDRP-equipped and IDRP-not-equipped airborne systems

3.5.5 Forwarding Information Base

Requirements have been expressed for accessing, via system management, the content of the IDRP RIBs of the managed BISs. The RIB contains inter-domain routing information which basically provide for a given destination, the Network Entity Title of the Next BIS on the path toward this destination.

The Forwarding Information Base additionally provides information about:

1. all known adjacent ESs and ISs (including Intra-domain IS and BIS)

2. the subnetwork address(es) (i.e. SNPA) of these neighbour systems for each subnetwork interconnecting the local system with these adjacent systems.

The FIB is the routing data base actually used by the ATN systems for forwarding the NPDUs. An invalid information in the FIB causes the failure of the forwarding function and consequently of the internetwork service provision. There is therefore a requirement from the system manager to have some levels of access to the FIB contents.

The following is proposed:

REQ25	The manager shall be able to get the list of the Network Entity Title of all neighbour ISs and the list of NSAPs of all neighbour ESs of a managed IS or ES.
REQ26	The manager shall be able to get, from the given NET or NSAP of a neighbour system, all SNPAs of this neighbour system on each subnetwork
REQ27	The manager shall be able to ask what would be the forwarding decision of a managed system for a given destination NSAP address and a given NPDU traffic type. The managed system shall reply with the selected next hop system (i.e. a NET or NSAP address), the selected subnetwork and the selected SNPA.

3.5.6 transport protocol entities

The objective is to evaluate the effectiveness of a Transport Entity to perform its task, i.e.:

- its capability to recover from loss/corruption/misordering of TPDUs, with consideration to the overhead (e.g. number of retransmission) introduced by the protocol

- its capability to accept/establish and maintain the required number of transport connections

In other words, the requirements are:

REQ28	performance management shall allow to detect an incorrect tuning of the transport protocol entity parameters (e.g. excessive number of retransmission, limit in the maximum number of transport connections that can be managed in parallel, etc...)
REQ29	performance management shall allow the computation of optimum transport protocol entity parameters

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