An Adaptive Management Model for Enhancing The Performance of ATM Networks

[1]Mohammad Al Rawajbeh [2]Majed Hussein

[1,2]Faculty of administrative and financial sciences, Management Information Systems department., Al Isra Private University 11622,P.O.Box 22,23 Jordan

Summary

Most global information networks now days are suffering from the problems of overload congestion and therefore decreasing in quality of services. These problems are caused by the cell lost ratio and repeated packets from intensive use the user application services.

These problems can be solved using an adaptive management system which offered in this research. This system offers an advanced method to prevent bottleneck cases and reduces the mount of repeated or lost packets (CLR). The mechanism of system is based on evaluating the degree of quality of services in a period of time. The general factors of quality are considered to make a self regulation in adaptive management system.

Key words:

Adaptive management, network performance, ATM network, Quality of service.

1. Introduction

ATM is a connection-oriented, unreliable (does not acknowledge the receipt of cells sent), virtual circuit packet switching technology. Unlike most connectionless networking protocols, ATM is a deterministic networking system — it provides predictable, guaranteed quality of service. From end to end, every component in an ATM network provides a high level of control.[2]

ATM Network is a technology that combines the flexibility of the Internet with the per-user quality of service guarantees of the telephone networks[1]

Congestion control techniques are vital to the successful operation of ATM based networks. Without such techniques, traffic from user nodes can exceed the capacity of the network, causing memory buffers of ATM switches to overflow, leading to data losses.

ATM networks present difficulties in effectively controlling congestion that are not found in other types of network, including frame relay networks. The high data rates and switching speed mean that significant chunks of information can easily be lost. Furthermore, for data traffic, the loss of even one cell can require the retransmission of thousand cells. The complexity of the problem is compounded by the limited number of overhead bits available for exerting control over the flow of user cells [3].

In networks as such, the burst information will be segmented into cells and the tremendous number of cells is traversed from sender to the destination via multiple hops transmission in the network. Not all traffic control methods can be applicable to the high-speed networks such as ATM [8,9].

2. Problem formulation

When the load of calls that coming from ATM users increased, they obtain failure in random order without selection, independently from the value or urgency degree of each call. That means, rising the probability of serving the low-valued and long calls instead of serving the short and high valued calls. Furthermore, that increase the number of failure calls which leads to increasing the repeated calls. As a result, appearance of overload and reduction in quality of services [4].

In [10] the proposed model, it was assumed that high priority traffic have been allocated a switch resource to guarantee a given QoS and low priority cells are allowed to enter the buffer, to improve the exploitation of reserved resources.

Thus, it is necessary to ensure at each moment of time to transfer through the network the most valuable for the users information and successful overloads reduction.

These problems can be resolved using an adaptive control system.

The use of such system will give the" ATM- Users" absolutely a new and important property of self-adjustment, which considered a sign of highly effective cybernetic system.

The principle of adaptive control (AC) based on assignment the value of tariff depending on the level of load of adaptive information of ATM users. AC provides the following advantages for the "ATM-Users" system:

- Filtering call by the criterion of information content values, as well as the value of information depends not only on the source of information, but to a greater extent on its content: major important calls can be made from any terminal device, the degree of importance is better to be assessed by users. Consistently, the user decides the basis of importance and urgency set of call.

Manuscript received June 5, 2009
Manuscript revised June 20, 2009

- Increases the likelihood of successful connections In case of overload valuable calls from the Users standpoint. That eliminates a large part of repeated calls and increased integrity and stability of the system " ATM-Users"; decreases the probability of overload and, consequently, the capacity of the network or its individual previously congested areas will be used to serve the most important calls, that leads to optimal allocation of ATM resources in order to maximize its effectiveness with respect to transfer the most valuable information, decreasing the number of failures, increasing the quality of service for ATM users as a whole.
- Decreasing the duration of user service in the highest load situation because of the high tariff, and thus decreasing the time of service by the own terminal device, and the probability of loss of incoming calls;
- Provides the ability to regulate the emerging overload situation in ATM–users system, which makes it possible to keep the load in some boundaries with presence of disturbing influences, as well as support the indicators value of quality of service for " ATM users" around the normal values, which positively affect the quality of users' services in a whole.

Since we are interested the management of technical systems, we will focus on technical problems only when discus the adaptive control system of “ATM-user” system. A particular interest is given to the functionality management of “ATM-User” system in real time, which occurs in conditions of incomplete information about the present state of the (ATM-user) system. This condition is characterized by minimum information about the past system, which is necessary for a complete description of the future behavior of the system. When developing the functionality of ”ATM” management in real time for adaptive control with no priori information formation about the conditions of its work. This makes constructing perspective of adaptive control systems “ATM”, which should have three functions:

1. Ensuring that current information about the present status of ATM users system ie, to identify the network. functionality process. This function corresponds to the task of automatic counting the number of calls for AC in ATM system.
2. Comparison the quality of system with the desired quality,
on the basis of this comparison a decision should be made to refocusing the system so that the quality of its work has sought to optimal. This task is consistent with the task of managing the functionality of ATM system in real time in Real time for ATM adaptive control.
3. Implementation of appropriate modifications to bring the ATM– user system to optimum.

The considered three features should be inherent in any adaptive management system, which is a combination of information processing algorithms and their implementation to achieve the desired goals of adaptive management in the ATM–user system.
The problem of adaptive management is a delay for obtaining the needed control information about the system for decision making, for example, appointment overload status over unit of information processing and management, while the choice of optimal routes for them to step forward.
This is related to the time in the process of information acquisition. Therefore it is urgent actual to provide an objective forecasting ATM–User system for adaptive management, i.e. load forecasting and losses as a result of automatic counting the number of calls.

3. Solution

Using the adaptive control system is a an effective tool in fighting against overload, which arise as a consequence of subscriber load, and due to the appearance of the equipment malfunction at any part ATM system (decreasing the number of normal communication channels).
Given the fact that the load of subscribers contains different information with different values, overload in whole network or any part could be eliminated by increasing the tariff of less important calls. In doing so, the capacity of the network or its individual previously congested parts will be used to service the most important user's calls.
As a variable, by which can make a decision, we take the magnitude of losses in communication channels, because of the overflow. However, in real networks such as ATM system, it is necessary to take in account of emerging and eliminates defective equipment. Then, the target variable of ATM system with adaptive control in real time will be the ratio of overall failure rate, which is defined as the sum of denials of service in a communication channel and the number of failed links in channel [4, 5].
The value of fare may be different for different directions (routes) in the network at the same time, depending on the overall rate of load in these directions. The use of high tariffs on the route is designed to reduce the load of values, where the fail ration would be sought to minimum.
Therefore the task of ATM–system management in real time with adaptive control can be formalized.
The management process in ATM system is seen in discrete time, which overrides values of governance parameters. The result is considered as t_m -selection of all controlled parameters at the time moment. Time interval in $R=R(t_m)$ is called a management plan for information

exchange, when the management plan remains constant, it called a control step.
The aim of management, in this case, the value of the overall failure rate of the network B^*, it is presented with the target variables V, where a measured inputs of the control object (CO) (in this case the CO –is a process of a calls service of ATM users), which characterize their condition, as well as restrictions that reflect the user requirements of quality of service. In this case, the measured inputs of CO is: X_m- number of established connections at the end of the observation period - the number of established connections for the period of observation; U_m - the number of considered connections for the period of observation; Y_m - the number of disconnection during the period of observation; B_m – number of failure due the overflow in a communication channel at the end of period of observation. Restriction is $X_m \leq L$, where L- the bandwidth of communication channel.
The values of target variables depend on the state of the environment $S = \langle M, H \rangle$, which is characterized by a multitude of controlled and uncontrolled inputs CO: $V = V\langle M, H \rangle$. It is needed to bring them into a state which provides extreme objective function, to solve the problem:

$$B^*(V\langle M, H^* \rangle), \xi) \Rightarrow \min \qquad (1)$$

Where $H^* = (X^* m{+}1, U^* m{+}1, Y^* m{+}1, B^* m{+}1)$ - the projected value of the measured inputs of DU, which are calculated on the basis of the measured values of streams and serviced streams.

To realize the purpose of managing B^*, complex algorithms F have to be developing a management command:

$$R = F(B^*, V, \xi) \qquad (2)$$

Which converts controlled inputs M CO in new condition (in this case, change the matrix of optimal routes M_{opt} to step forward).

Thus, we can formulate the optimization problems of adaptive management in (ATM-user) in real time with adaptive tariff: using measured and projected assessment of load and losses in the (ATM) is required creating a list of the best routs and tariffs, and appoint them in such a way as to prevent or eliminate the network overload and use bandwidth to service only the most valuable in terms of users' calls.
The solution of such problem would be a management plan of information exchange $R = R(t_m)$, which gives the state of controlled inputs of ATM. On the basis of given information which includes the goal of management B^*, the state of the measured inputs of (ATM) $V = \langle M_t, H^* \rangle$ the restriction ζ control system is mandate to develop the management command R, under which the managed (ATM) inputs are translated into a new state, which in this case the change of route and tariff lists. In figure.1 presented a structure schema of adaptive management for (ATM) [6,7].

4. Results

As seen in figure.1 a structure schema of adaptive management can be used to avoid the overload situations and reducing the mount of losses and repeated packets. The decision can be made now depending on the state of communication channel parameters and the restrictions which reflect the requirements of users to quality of service.

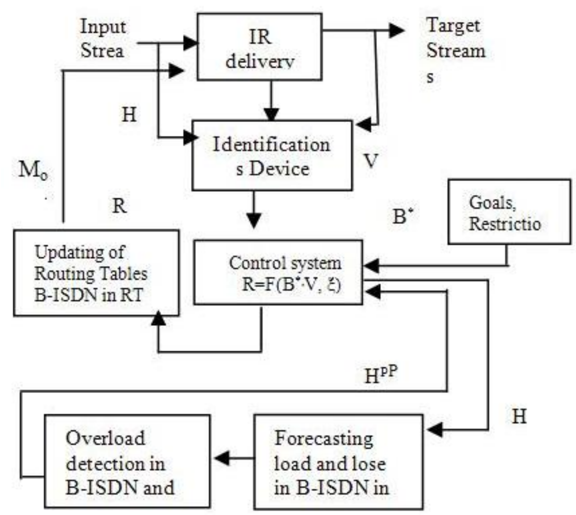

Figure 1: Adaptive Control System

Where:

H: Entrace Streams.

V: Target variables.

M_{opt}: Matrixes of optimum routes.

B^*: Size of the general factor non- throughput networks. (Goal of Management)

ξ: Restrictions reflecting the requirements of users to quality of service.

- $H^* = (X^* m{+}1, U^* m{+}1, Y^* m{+}1, B^* m{+}1)$ -

predicted values of measured inputs O M which are calculated on the basis of the measured values of entering streams and the served streams.

5. Recommendations and future work

To solve optimization problem in the management of ATM in real time with AC mechanisms a collection of algorithms should be developed:
- An algorithm to measure and predict the load and losses in the ATM;
-An algorithm for detecting overload in communication channels and information processing and control unit of ATM in real time;
- An algorithm for updating routing tables of ATM in real.time;
- An algorithm for user's calls service of ATM for adaptive control.

References

[1] Keshav, S., 1997. An Engineering Approach to Computer Networking: ATM Networks, the Internet, and the Telephone Network. AddisionWestley Longman Inc., Massachusetts, USA.

[2] www.technet.microsoft.com/en-us/library/cc783455.aspx#w2k3tr_atm_what_qfix.

[3] William Stalling. Business data communications, Fourth edition, , pp.329. 2002.

[4] B.S.Goldstein, Development of the switching technics: experience ATC-90//Radio.. № 4, 5. 1999.

[5] S.A .Yakovlev, methodical of a basis of use of imitating modelling in educational process by preparation in a direction 654700 - Information systems. - information-operating systems. 5 (12). pp.44-49. 2004

[6] S.A .Jakovlev, A.H .Svetov. About methodology of construction of the distributed intellectual information systems. - Izv. «LETI»,. Sulfurs. Computer science, management and computer. pp. 45-49, 2002.

[7] J. A moss, D. Minoli. IP Applications with ATM. McGraw-Hill Series on Computer Communications, pp. 363 .1998.

[8] M. Allman, V. Paxson, and W. Stevens. "TCP Congestion Control", RFC 2581, 1999.

[9] E.P. Rathgeb, "Modelling and performance comparison of policing mechanisms for ATM networks," IEEE Journal on selected areas in communications, Vol. 9, No. 3, pp.325 – 334,1991.

[10] Francis Joseph Ogwu, Mohammad Talib, Ganiyu Adesola Aderounmu. Improving the Quality of Service Guarantee in an Asynchronous Transfer Mode (ATM) Network. Journal of Computer Science 3 (11): 847-853, 2007.

Mohammad Al Rawajbeh
Work as assistant professor, head of MIS department in Al Isra Private University-Jordan. His research interest includes policy based network management. Obtained the Bachelor and Master-Engineer degree in computer science from Kharkov National Polytechnical University (KNPU) in 1996. PhD degree in computer networks management from Kharkov National University of Radioelectronics (KNURE) - Information and Control Systems department in 2000.

Majed Ismail Hussein
Work as assistant professor in MIS department in Al Isra Private University-Jordan. His research interest includes policy based network management.
Ph.D: Information Management Systems and processing, Saint Petersburg State electrotechnical University,Russia,2006. M.Sc.: Information Technology and Computer Equipment, Saint Petersburg State electrotechnical University,Russia,1999. B.Sc.: Electrical Engineering,Aleppo University,1993.