ATM networks - problems.

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Abstract: As a result of the development of the Asynchronous Transfer Mode (ATM) technology, in the wired as well as in the mobile networks, there appears fast and reliable infoBuses ready to maintain new services. Except reaching a broad band, the aim is to improve the effectiveness and flexibility of the system.

Because of the high demands of quality of the services of ATM and the existence of comparatively complex controlling algorithms, the role of the standardizing committees increases.

UTI-T and ATM Forum are those, who work in the direction of merging of the different approaches for solving the problems with ATM, as far as if is possible and an investigation of their compatibility.

The aim of the present work is to reveal complexity of the problems with ATM, grouping them in a suitable way. For every group of problems is shown the actual state. Some of the proposed solutions, advantages and disadvantages are offered too.

Preface: ATM is a communication standard [3] that divides all the traffic in information fixed-length packets (cells). These are switched at a high speed. The world wide spreading of Internet and multimedia applications set ATM networks as the backbone in different parts of Internet.

In the present the traffic is not the same, as ATM protocols have been designed. Voice and IP (Internet Protocol) traffic types are predominant. There are many possible alternative network architectures in that way separate network elements are not required for every ISO layer. Some base network functions are realized in several layers. For instance, the specific for ATM Quality of Services (QoS) is considered as a function of data-link layer (2 according to ISO). By means of Resources Reservation Protocol (RSVP) QoS will be probably comprised in network layer (3) as well as with the improved Frame Relay (FR) again function of layer 2.

Table 1 summarizes six schemes of network elements, which cover the lower 3 layers and the optical sublayer (with Wavelength Division Multiplexing- WDM).

It is not mandatory to use an optical sublayer in each scheme. Only in scheme 5 it is necessary. All the rest may terminate in Synchronious Digital Hierarchy- SDH/SONET (scheme 2) or ATM (schemes 1, 2, and 3). Scheme 6 is variation of schemes 1, 2, and 3 but FR replaces ATM.

Scheme	Summarized description
1. IP + ATM + SDH = B-ISDN	Many network elements; See also scheme 6
2. ATM	Include ATM w/o SDH, as well as ATM/SDH hybrid; See also scheme 6
3. Switched Routing	ATM/IP hybrid; See also scheme 6
4.IP over SDH	PPP or IP in HDLC format, adjusted to SDH
5. Optical IP	PPP or IP transport in HDLC format over WDM
6. Frame Relay	Frame Relay takes the place of ATM in Schemes 1, 2 or 3

Table 1The alternative network architectures

Independently of the existing technological and applied solutions with ATM networks there are problems whose solutions are debatable and a subject to additional investigation. In this work the problems connected with IP over ATM, performance and buffering requirements of Transmission Control Protocol (TCP) over ATM Available Bit Rate (ABR) and Unspecified Bit Rate (UBR) services, and Call Admission Control (CAC) have been presented.

I. IP over ATM. IP networks are built on network layer (3) and based on packet routing. The ATM technology is based on hardware layer 2 to switch the cells. It appears naturally to be found manner to route on the layer 2. That is the reason why some problems have to be solved:

Addressing Internet and ATM are kept within two different and completely independent addressing schemes. The public ATM networks are based first of all on E-164 addresses, while private ones are kept within OSI Network Services Access Point (NSAP). The present IP (version 4) is based on four bytes address field. Still it is not clear how to put ATM addresses together with the new IP addressing scheme (ver. 6).

Signaling and Routing. When we talk about signaling we understand the messages that are exchanged between the user and the network, or between the network nodes during the call set-up process. The protocol stacks with User Network Interface (UNI) and Network Node Interface (NNI) are specified by ATM forum as well as International Telecommunications Union (ITU-T). Regarding to NNI there is an essential difference between the maintained by ITU procedures concerning mostly the public ATM networks and these of ATM forum, which are applied at private ATM networks. ITU maintains the fact that Broadband-ISDN User Part (B-ISUP) protocol has to use in public networks.

On the other hand, ATM forum has taken a completely different UNI protocol- Private NNI (P-NNI). The latter is based on the UNI protocol. Besides signaling protocol P-NNI comprises protocols for automatically recognition of the topology as well as routing over the base hierarchy network structure.

Another important problem is how to allocate a sufficient transfer capacity of *supporting the high speed of the communications* (not only IP). For instance, the transport by ATM services ABR or UBR is convenient in case of data transfer.

Proposed solutions. The Multiprotocol Over ATM (MPOA) architecture is depicted in fig. 1. A MPOA server carries out the functions: registering and processing of the addresses, configuring and processing of the broadcast, multicast, and unknown packets as well as the routing server functions. This server finds addresses beyond Internet Address Subgroups (IASG) that are united in the aim of routing.

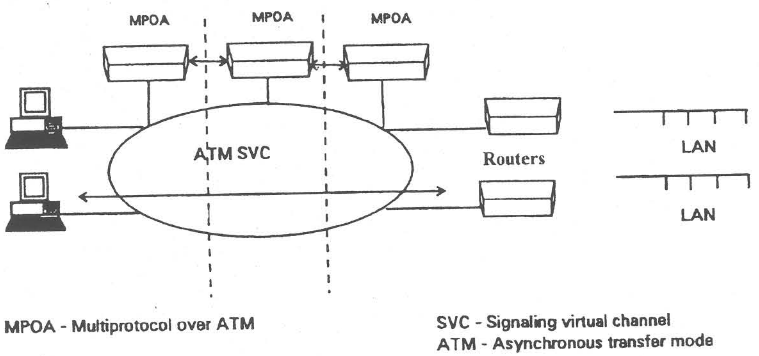

Figure 1. Multiprotocol over ATM.

Multiprotocol Label Switching (MPLS) has recently appeared solution [2] of Internet Engineering Task Force (IETF). It is based on the standards and designed to ensure better scalability and high performance with IP using in Wide Area Networks (WAN). In comparison with the different protocol, MPLS is designed for as ATM networks as well as non-ATM networks (FR, Ethernet etc.). By means of identification of preliminary determinate route across network between whichever two nodes MPLS adds mechanism for building logical links to IP. Every route is associated with label called Label Switching Path (LSP).

A router at the edge of the network (known as Label Edge Router-LER) analyses the IP header and determines which LSP to be used, adding a relevant label to IP packet with its forwarding to next hop. This label is only used to make a decision about forwarding by every next MPLS node (known as Label Switching Router - LSR). As a result of that an extremely high speed is obtained.

In MPLS/ATM environment the label is actual VPI/VCI (Virtual Path/Circuit Identifier). In this way, IP switching is realized with the maximum possible speed for the corresponding ATM networks. By means of usage of the Label Distribution Protocol (LDP) is decided problem with the large number (even in middle size networks) of the LSP paths.

Because of the requirements of IP based Internet services of low delay, high speed, and high QoS, communications such as ATM hold out, MPLS and MPOA probably will be forced. Standardizing committees are those, that work in the direction of merging of the both approaches, as far as if it is possible and an investigation of their compatibility. Convergence is in progress as the next step is the effective integration of MPOA and MPLS. It is recognized by ATM forum as well as IETF.

II. TCP/IP over ABR and UBR. It is very important to evaluate the performance and buffering requirements of TCP over ATM- ABR and UBR services with or without packets loss. The influence of the buffer size, the threshold, and minimum packet length over Packet Lost Ratio (PLR) is insufficiently investigated.

Proposed solutions. The ABR service requires network switches to constantly monitor their load and feed the information back to the sources (figure 2), which in turn dynamically adjust input into the network. For UBR service, the switches monitor their queues and simply discard cells or packets of overloading users.

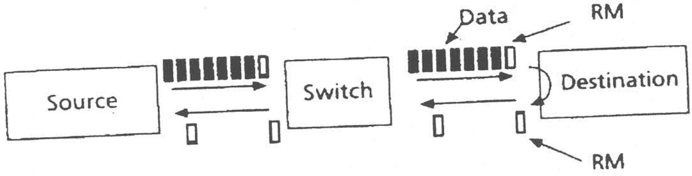

Figure 2. *The ABR traffic management model: source, switch, destination, and resource management cells.*

TCP does have the intelligence built into it in the form of the "slow start" (figure 3) congestion avoidance mechanism [3].

The maximum buffer requirements for TCP over ABR without any loss (using simulations) is approximately:

(a*RTT+c*Tfb)*B, where:

RTT – Round Trip Time,

Tfb – Feedback delay,

B – Link bandwidth.

In [5] it is produced that factor **a** is constant with maximum 3, and **c** is 0 (log number_of_VCs), and its value is not greater then 4. Ibid. it is produced buffering requirements of TCP over UBR without packet loss is sum of **MAXWIN**s of all TCP connections. In this respect TCP over UBR is not applicable.

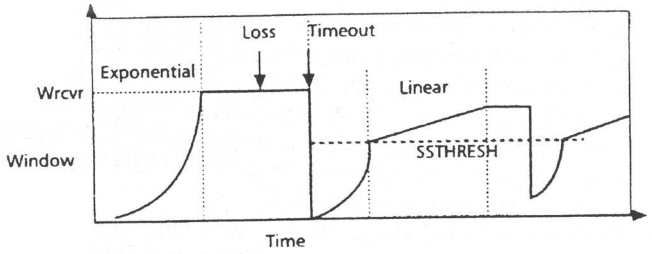

Figure 3. *TCP window vs. time using slow start.*

Even limited buffering, TCP througput and fairness over UBR can be improved by buffer allocation and cells discard policies.

Early Packet Discard (EPD) policy [1] requires in case of reach a preliminary determinate threshold, entire packet to be discarded instead of random cells from multiple packets. With Partitial Packet Discard (PPD) in case of full buffer all cells from this packet is discarded to the its end. It is proposed policy [1] called Active Cells Discard (ACD). Its basic advantage to the rest is in case of short packets, then PLR is less approximately 100 000 times.

III. Call Admition Control (CAC). The problem of *determining the bandwidth requirement* of connections and of the aggregated traffic at entry and intermediate nodes in the network by taking into consideration the effect of multiplexing , source and traffic characteristic, cross traffic, and buffer sizes largely remains an unsolved issue.

CAC deals with determining the amount of bandwidth required by a connection for the network to provide the required QoS.

Various CAC algorithms have been proposed in the references of [4].

*Proposed solutions.*The *equivalent bandwidth* method and *Gaussian approximation* do not take the buffer size into consideration. The result is often highly conservative when buffers are small or of moderate size .

In order to to address this criticism and to provide better utilization of the multiplexing gain, in [4] a compromise approach for the required bandwidth for many VBR sources has been suggested. The suggested required bandwidth is give by:

MIN{Ce, Cg} , where

Cg and **Ce** are, in fact, the required bandwidth calculated from equivalent bandwidth method and Gaussian approximation respectively.

Diffusion- Based CAC. Extensive numerical and simulation results demonstrate the efficiency and adequacy of this CAC procedure [4]. The CAC procedure uses an information vector:

$$I=\left\{ \left[\lambda = \sum_{u} \lambda_{u}\right],\left[\sigma^{2} = \sum_{u} \sigma_{u}^{2}\right],\left[\alpha = \sum \lambda_{u} c_{u}^{2}\right] \right\}$$

which contains the status of current connections on each corresponding link. Note that **I** is calculated using the aggregate arrival rate λ, the traffic aggregate bit rate variance σ, and α, which is the cell arrival process instantaneous variance.

For statistical bandwidth **Cdf** (function of the traffic, buffer, and Cell Loss Ratio- CLR), and link capacity **Ce**, let **U** be the information vector of the incoming connection request. This CAC procedure uses the following algorithm. For each link along the selected path:

1. update I $\leftarrow$ I+U;
2. calculate Cdf;
3. if Cdf $<$ Ce , accept;
4. if Cdf $>$ Ce, reject and restore I $\leftarrow$ I - U .

Conclusion: In this work some groups of problems connected with ATM are presented. The actual state of every group is shown. Some of the solutions, advantages and disadvantages are proposed too.

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