Abstract

ATM is first technology that is capable to interconnect LANs and WANs into a seamless TAN (Total Area Network). Despite a very tough competition from Gigabit Ethernet in LAN, the ATM is still strong in WAN access market. At present ATM technology is most appropriate for digital video network for broadcasting and contributes to the convergence of telecommunications and broadcasting.

The ATM forum finished a complete 4.0 protocol suite [7] in 1996 and the ATM switches, with complete 4.0 protocol, came out in 1997. ATM switches without 4.0 have really not had any significant advantage over today's LAN, except speed. However the support for mixed voice, data and video over LAN and WAN is very effective in ATM switch following ATM forum specification.

No other protocol in history has existed, which includes signaled QoS, Explicit Rate flow control, or QoS routing. All are critical to operating a network with low delay and QoS. However, this protocol suite need not be locked to ATM switch hardware, it could be used on any switch platform and over any link protocol.

While the ATM Forum Traffic Management specification version 4.0 document gives a complete description of the end system behavior, it gives only a high level description of the switch or intermediate network nodes, leaving the details of their behavior vendor implementation dependent. This prompts and motivates us to undertake this investigation.

Some years ago it was believed that ATM will be the only universal service in future and ATM was hyped to replace IP. After ten years of it's birth, ATM has matured now and while providing excellent infrastructure for IP and voice services, it is the only QoS capable network technology one can buy and implement today. The ATM and IP are not only co-existing but ATM-IP collaboration is becoming increasingly popular and useful.

ATM-IP collaboration assumes special significance because the Internet is one of ATM's best customers and that IP benefits greatly from ATM features which are IP-specific. QoS Interworking for end-to-end Services is under current investigation [26] and there are fresh efforts to map IP and ATM QoS parameters to support end-to-end IP services.

For ATM networks, the Quality of Service and Congestion Control has recently been the subject of extensive research [20]. The ABR (Available Bit Rate) of QoS category is intended to support data traffic on ATM networks so that it can efficiently coexist with traffic from other service classes, such as CBR (Constant Bit Rate) and VBR (Variable Bit Rate). To support ABR traffic, the network requires feedback mechanism to use the leftover bandwidth and control the flow of traffic accordingly. The Rate-Based flow control Framework has been suggested [30] for ABR service and ABR continues to be in the limelight for the discussions concerning various Feedback mechanism and Congestion control schemes.

Congestion control refers to the set of actions taken by the network to minimize the intensity, spread and duration of congestion. Congestion can be caused by unpredictable fluctuation of traffic flow and fault conditions within the network. Most of the traditional data applications can not predict their own bandwidth requirements and therefore can not reserve resources in

advance as in the case of voice telecommunications networks. Thus an explicit guarantee of service can not be provided. It is clear that the long lasting congestion will occur in ATM networks from time to time, whenever the demand for network source exceeds the capacity of network resources

The Congestion Control may involve different components in a network, including the host machines of the sources and destinations, as well as switching nodes. Traditionally, acknowledgement-based control is exercised, which makes use of the information fed by the destination node to regulate the input traffic. In broadband networks, the propagation delay is much longer than that in narrow-band networks; consequently, the acknowledgement-based control mechanism is not suited in technology like ATM. Due to the large feedback delay, conventional feedback scheme performs poorly in achieving high throughput and low queuing delay / loss probabilities. In addition, window based flow control and the 'first-come-first serve' policy can neither satisfy some performance requirements nor provide firewalls among connections. Therefore, some Rate-Based congestion control mechanisms have been proposed [21-24]. It is often difficult to characterize and compare various features among these congestion control schemes.

Recently some researchers identified the role of Feedback-based flow control scheme in ATM networks [31] but mostly studies were focussed on specifying conditions under which the feedback scheme offers improvement over the open-loop scheme. This thesis studies the QoS mechanism and compares the performance and responsiveness of various Rate flow control schemes for ATM. The QoS features, with special reference to VBR is studied at three levels, namely mathematical modeling, Simulation and Testbed realization. The objective is to facilitate the analysis of the various networking issues like, Bandwidth / Link utilization, Cell Loss Statistics etc. Some of the computer applications are specially investigated with respect to implementation on the ATM Testbed, thus validating simulation findings. The simulations are done with a series of models after "Model validation & sensitivity analysis", and is concluded with the results on communication behavior of computer application models, varying with Poisson characteristics.

The Simulation is extended for comparative evaluation of existing '*Binary Rate flow control scheme*' and '*Explicit Rate flow control scheme*'. The results gives a significant recommendation of introducing Explicit Rate into Internet flow control mechanism and goes deep into the two Explicit Rate feedback control schemes, namely EPRCA (Enhanced Proportional Rate Control Algorithm) and ERICA+ (Explicit Rate Indication for Congestion Avoidance). In our investigation, the two schemes are compared and conclusions about the responsiveness of EPRCA and ERICA+ schemes were drawn. The parameters Available Cell Rate of the source end system are recorded with the corresponding time-stamps and graphs are plotted. The upward shift of 'EPRCA source ACR graph' leads to the conclusion that the network utilization and thereby the bandwidth are more for EPRCA rather than ERICA+ scheme. Similarly, the throughput is calculated by recording the 'Cells received per second' and the resultant graphs indicate that throughput for EPRCA is again more than ERICA+ scheme. Our investigation thus stresses that however ERICA+ scheme have smaller queuing delay compared to the EPRCA scheme, but if one prefers to choose ERICA+, the 'link under-utilization' is the price tag which one has to pay for lower buffer occupancy level.